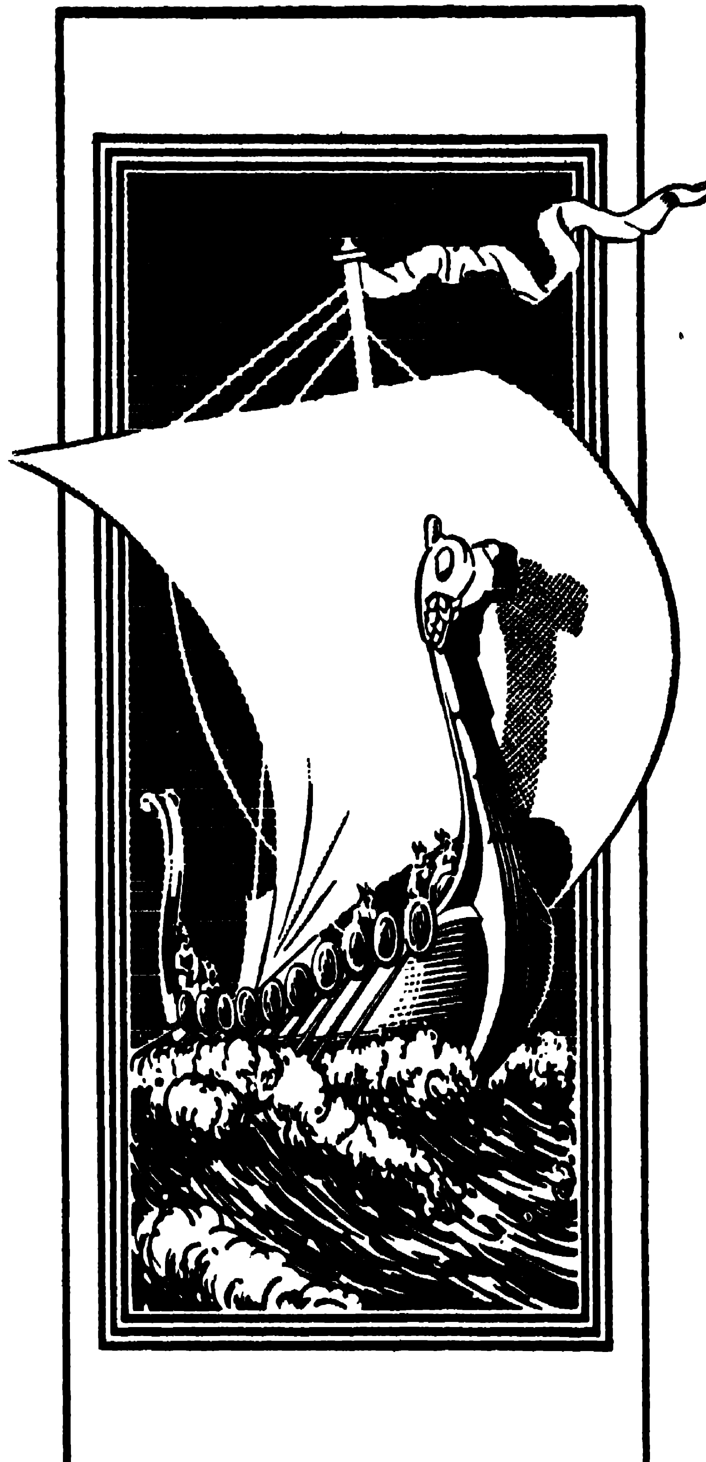

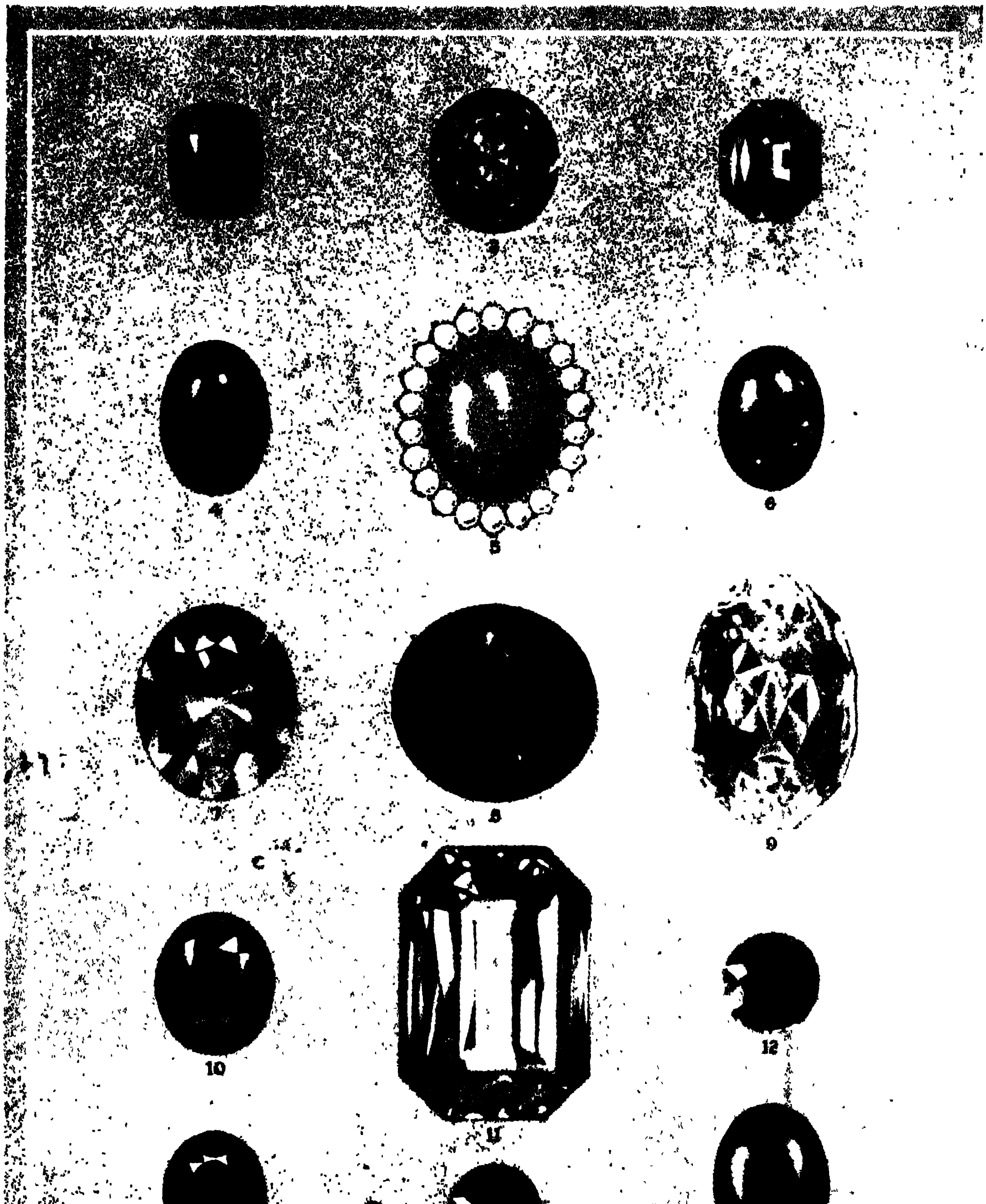

Here are a few of the precious stones, each cut to bring out its beauty. 1. Ruby, from Burma. 2. Blue sapphire, Ceylon. 3. Topaz, Brazil. 4. Jade (jadeite), Mogaung, Burma. 5. Turquoise, Egypt. 6. Opal, Australia. 7. Zircon, Ceylon. 8. Quartz amethyst, Urals, Russia. 9. Kunzite, Pala, California. 10. Garnet, South Africa. 11. Aquamarine, Minas Geraes, Brazil. 12. Spinel, Ceylon. 13. Tourmaline, Brazil. 14. Garnet (pyrope), Gallup, New Mexico. 15. Opal, Australia.

Richards Topical Encyclopedia

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COLOR PLATES

KEY TO PRONUNCIATION

ā, as in māte
â, as in senâte
â, as in hâir
ă, as in hăt
ä, as in fäther
à, a sound between a and ă, as in càstle
ch, as in chest
ē, as in ēve
ê, as in rêlate
ĕ, as in bĕnd
ẽ, as in readẽr
g, as in go
ī, as in bīte
ĭ, as in ĭnn
k, as in key
K, the guttural sound of ch, as in the German *ach*, or the Scotch *loch*
n, as in not
N, the French nasal sound, as in *bon*
ng, the English nasal sound, as in strong
ō, as in bōne
ô, as in Christôpher
ô, as in lôrd
ŏ, as in hŏt
oi, as in toil
o͞o, as in so͞on
o͝o, as in bo͝ok
ou, as in shout
s, as in so
sh, as in ship
th, as in thumb
th, as in thus
ū, as in cūre
û, as in accûrate
û, as in fûr
ŭ, as in ŭs
ü, a sound formed by pronouncing ē with the lips in the position for o͞o, as in the German *über* and the French *une*
zh, as in azure
', an indication that a vowel sound occurs, but that it is elided and cannot be identified, as in apple (ăp''l)
A heavy accent (′) follows a syllable receiving the principal stress, and a lighter accent (') follows a syllable receiving a secondary stress.

Reading Unit
No. 1

WHERE OUR FASHIONS CAME FROM

Note: For basic information not found on this page, consult the general Index, Vol. 15.

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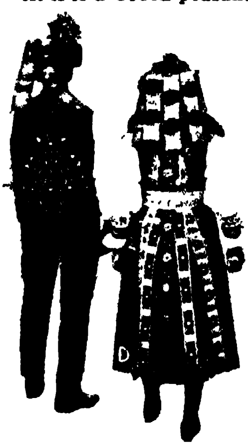
Summary Statement

Fashions keep pace with progress and are always created by people.

WHERE OUR FASHIONS CAME FROM

The simple folk of all the older nations still wear, especially on gala days, the costumes their ancestors have worn for generations. At A is a Greek peasant.

B. These becoming costumes come from Sweden. C. Bright colors please the eye in this Norwegian costume.



D. The peasants of Czechoslovakia are as amazing behind as before --and we may be sure that they are not afraid to wear bright colors.

E. In lower Austria peasant lassies wear these becoming clothes.

The young man at H does not feel conspicuous when he is at home in Czechoslovakia.

This Hungarian bride and groom have put on their best to grace their marriage day. In some countries elaborate headdresses and heavy embroideries like these are often handed down for a number of generations.

Every little district in Holland has its own peasant costumes, but in most of them wooden shoes like these are worn. The full trousers are typically Dutch.

I. These hats may not be worn in Paris, but in a certain corner of Germany no peasant lass would feel that she was looking her best without one of these interesting shovels on top of her head.

This early family is on the march from watercourse to watercourse. Clad in the rudest skins they trudge along, the strong bearing the weak; and nothing but a thatch of hair protects their heads from the sun.

WHERE OUR FASHIONS CAME *from*

Who Is It That Makes Our Styles? And What Have the Styles Been All through the Ages?

IF YOU had to guess, what should you say were the first coverings early men ever put on their bodies? Were they the bearskin of some ancient hunter or the grass cloth of some early savage? No, those who have studied the subject tell us that probably the very first thing men ever wore was a bright coat of paint or a durable dress of tattoo. We know that long before savages find out how to weave fabrics or to tan hides, they always adorn themselves with feathers and flowers and bear's claws—or perhaps with the scalps of their enemies—and make themselves "beautiful" by staining their bodies or filing down their teeth or flattening their heads or pinching in their waists with tight iron bands. And of course they wear nose rings, earrings, finger rings, bracelets, anklets, and girdles.

It may well be that their first real article of clothing was suggested by the girdle. For what could be more natural than for some dandy or belle to hang grass or flowers or feathers from it. In this way a fashion would be set which everyone would follow, and the result would be the loin cloth or short grass skirt, which seem to have been the earliest dress that people took a fancy to.

But they did not feel much more dressed up in a loin cloth than they had felt in their necklaces of sea shells. And before they ever knew how to put on a garment they would have been just as much embarrassed to appear without their coat of paint as we should feel to find ourselves on the street without any clothes at all. For whatever people are used to is what seems to them to be proper. Women in some of the Mohammedan countries to-day would never dream of appearing before men without a veil over their faces, and in Central Asia they would be horrified to let anyone see their fingertips. Like us to-day, an early

WHERE OUR FASHIONS CAME FROM

A. These amazing West African costumes are more for style than use. The mask at the right is made of mother-of-pearl.

B. Anything uglier than this West African fashion of doing the hair it would seem hard to find. Yet the pompadours worn at the beginning of this century were hardly more beautiful.

C. These Kihuyn boys from Africa feel thoroughly clad in their coats of bright paint, and beyond a doubt are charmed with the effect.

D. The ample robe worn by this African native has been made of grass, a handy material which he employs for certain ceremonial garments.

E. Their handsome leopard skins make an effective dress for the black bodies of these African natives.

F. Like the costume at D, the one shown here is made to be worn in a ceremony in which some animal is impersonated.

G. At Angola, in East Africa, the girls feel very smart when they are arrayed like this.

G

Photo by Field Museum

man felt properly dressed in whatever everyone else was wearing.

The poet Hood says all this quite neatly:

"Both he and his people were black as sloes,
For the region they lived in was torrid;
And their principal clothes were a ring through the nose
And a patch of red paint on the forehead."

But then perhaps one day the strong man of the tribe came strutting home wearing about his shoulders the skin of some great animal that he had killed. That would at once start a rage for the wearing of furry capes, and every hunter would save the best pelt he could get to wear on great occasions. It is hard to say whether he liked it most because he felt that it made him more imposing or because, even in that hot climate where the first men lived, the nights were often cool and a bearskin cape came in quite handily.

Photo by National Museum · American Museum of Natural History · C B and Q. Railway

At the left is a Papuan from the island of New Guinea. The gentlemen of his tribe delight to gather their hair together into bunches, which they wind with grass or some vegetable fiber to make the strands stick out. Sometimes a single head may boast as many as seven hundred of these bristling ornaments. In the center above is a native woman of one of the South Sea islands, where the people love to decorate themselves with garlands. That the American Indian at the right is a chief, you may easily guess from his magnificent headdress of eagle feathers.

Of course the king or chief claimed certain special rights in the matter of dress, and so did the principal men of the tribe. Even before there was anything that we should call clothes, a man's rank was shown by his special adornment. Later, in early Egypt, the king wore a lion's tail as a sign of royalty, but none of his subjects might sport this charming ornament. Crowns or other royal emblems have been worn by rulers ever since the beginning of time, and robes of "royal" purple or of ermine. To-day a monarch carries on state occasions a scepter, wrought of gold and studded with precious stones.

When we first glimpse men through that long spyglass known as history, we see them already quite pleased with themselves in a single short garment made of wool or flax. To be sure the lower classes could not aspire to such grandeur—nor even to the elegance of a loin cloth—but the "best people" in Sumeria five or six thousand years ago wore a kind of scanty nightgown, often made of unspun wool, which left one shoulder bare. On top of this a well-to-do man or woman could throw a heavy cloak, but the pictures show that only gods and kings might ever put on a hat. To make up for this, both men and women wore their hair long; and the ladies of Ur, in Sumeria, were proud of their vanity cases.

At about the same time in Egypt men of the upper classes felt smartly dressed in a short white linen kilt. Later this was made long enough to reach up to the armpits, and if a man put on a good deal of style he had his garment starched—and a king might even wear a colored one.

As time went on, the lower classes began to wear loin cloths, and before long these too turned into skirts. For though a loin cloth was merely drawn about the waist and tied or folded in front, it was easy enough to lengthen the ends into

WHERE OUR FASHIONS CAME FROM

From ancient Egypt come the four figures at the top of this page. They give an excellent idea of the simplicity of the garments worn by the Egyptians, in a climate that was very hot. Very early the Egyptians began to shave their heads and wear wigs, but it was not till quite late that the wearing of sandals became common. The favorite fabric was linen, which was often starched and pleated.

The four lower figures on this page are clad in the costumes of the great days of Greece. The Amazon on horseback is in the single seamed garment known as the chiton. The man in the lower left-hand corner is wearing a kind of cloak made of a square of woolen stuff and called a himation (hĭ-măt'ĭ-ŏn). The other two figures are clad in the peplos, the front and back of which were fastened together at the shoulders with brooches.

WHERE OUR FASHIONS CAME FROM

On this page are various forms of Roman costumes and of costumes derived from the Roman, for the general fashion of wearing a loose outer garment over a tight under garment, or tunic, lasted for a good many centuries, in one form or another.

A. This statue of St. John, like the one of St. Thomas at B, shows the figure clad in garments that developed from those worn by the Romans; for both of these statues were made centuries after the time of Christ. By this time the Roman toga had been replaced by the pallium, as shown here; and the under tunic had taken on sleeves.

At C is a picture of the Holy Family, painted long after the time of Christ. It shows how the Roman dress had changed during the passing years. At D and E are costumes of the great days of Rome. The man at D is wearing a toga, for he is dressed for a formal occasion. The woman at E is wrapped in a palla, under which she wears a tunic known as a stola. On her feet are a pair of sandals.

This statue of Augustus Caesar shows the Roman emperor clad in a short tunic under a metal corselet chased with figures, some of which represent Apollo, Diana, Mars, and the provinces of Gaul and Spain. The tiny figure is Cupid astride a dolphin, a reminder that Augustus was descended from Venus!

an apron which finally reached to the knees, and then to widen the apron into a skirt that extended all the way round the body. After cotton was discovered and the arts of spinning and weaving were improved, garments became more and more elaborate, and styles changed—but only once in a very great while.

By 1900 B.C. clothing was growing more graceful. People were learning how to drape a shawl or cape so that it hung in soft folds. In Greece these draperies were often very beautiful, probably as artistic as any costumes the world has ever seen, and the same dignified and comfortable fashion was adopted by the Romans.

The Greeks wore next the skin a long, sleeveless linen tunic that they called a "chiton" (kī'tŏn). Over this they draped a large oblong of woolen cloth called a "peplos" (pĕp'lŏs). It was about a foot longer than the wearer was tall, and was wrapped around the body from head to foot and held in place by pins or brooches.

In Rome the outer garment was called a toga (tō'gȧ). At first it was worn both by men and by women, but in later times the Roman women wore a costume like that of the Greeks. The toga was semicircular, much like a modern cape, and the straight side, which was about three times as long as the wearer was tall, was always worn uppermost. The adjustment varied. Often one end hung down in front over the left shoulder nearly to the ground The other end was brought around the back to the front, either over or under the right arm, and was then thrown over the left shoulder in such a way as to hang down behind. These draperies were held in place by beautiful ornaments or girdles, and of course a person could arrange the folds to suit himself, and the fashion changed from time to time. To wear a toga gracefully required a certain art: and though at first no man ever appeared on the street without one, the garment gradually came to be donned only for special occasions.

Photo by American Museum of Natural History

This Indian belle of the Florida Everglades knows that she is irresistible in the costume of her people.

The "manly toga," which was the ordinary dress of the Roman citizen, was of plain white wool, and was put on by a boy when he reached the age of about fourteen. Before that he wore a

When the Hopi Indians, in the southwestern part of the United States, hold one of their snake dances, they come dressed for the occasion in the costumes shown below.

Photo by National Museum

The gowns on this page belong to a period when the art of coquetry was at its highest. The Duchess of Orleans and her little daughter (A) were painted at the opening of the 19th century. The firm-looking person at B is a 17th century Dutch woman of the middle class.

D. A 17th century French lady of high rank, wearing a wide ruff. E. Queen Marie Antoinette of France, with her two children—painted late in the 18th century.

C. Anna Carolina, queen of Naples, as she was painted late in the 18th century. F. This 17th century French lady of high rank is wearing widow's weeds.

In the olden days children, like little dolls, were dressed just as their elders were. At G are the two children of Queen Marie Antoinette, painted in the latter part of the 18th century. At H is a little Spanish princess of the first part of the 18th century.

The beautiful Empress Eugénie, who ruled the French court in the middle of the past century, is surrounded by her maids of honor, all of them dressed in the styles which the Empress herself created. It is a common saying that fashions repeat themselves. So we need not be surprised that the styles of the Empress Eugénie have been revived of late years. In the same way very full sleeves come back from time to time.

This was the stately dress worn in the middle of the 18th century. The painting shows a grandson of Louis XIV with his family, members of the small group of French nobility who set the styles for the world.

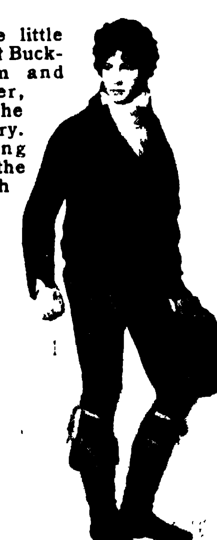
WHERE OUR FASHIONS CAME FROM

Here are some of the gay clothes men have worn in the past four centuries. The knight at A lived in Florence in the 17th century.

Can you imagine what a sensation the gentleman at B would create if he wore those clothes to church to-day? C. A French musketeer of the first part of the 17th century. E and F. Gentlemen of the 17th century.

D. French gentleman of the 18th century. G. Charles IX, king of France in the mid-sixteenth century.

H. The little Duke of Buckingham and his brother, painted in the 17th century. I. A young man of the early 19th century.



toga with a purple border, and so did the magistrates. A purple toga with embroidered decorations was worn by generals who were celebrating a triumph, and with this went a gold-embroidered tunic. Emperors too might wear the purple toga—and so we get the phrase "born to the purple," which means of noble birth. This was not purple at all in our sense of the word. It was really a beautiful deep crimson that came from the famous Tyrian dyes. The tunic too might be decorated with purple for men of a certain rank.

Of course there never has been an age when people did not wear all sorts of jewelry and other ornaments. A man in Rome might load all his fingers with rings, though at first a Roman citizen would wear only an iron signet ring; for a long time the gold ring was a sign of rank. The Egyptian belle, too, had a battery of devices that would command the respect of many a modern coquette. Rouge, perfume, brooches, rings, beads, bracelets, armlets, hairpins, hair nets, and veils, all were to be found on her dressing table. Veils were fashionable in early Greece too, for Homer mentions them; and in all the oriental countries women knew how to wear them in order to add just the touch of mystery which makes beauty so alluring. Do you remember that in the Bible when the beautiful Rebekah arrived at the home of Isaac, she covered her face with her veil before she went forward to meet her future husband?

lar Publishing Co

This picture of Isaac blessing Jacob was painted in modern times, and shows the artist's idea of what their costumes may have been like. We have no very clear description of the dress of the Hebrews of that early day, but we know that in general it was made up of an under garment, either a loin cloth or a tunic, and an outer garment that might take a good many different forms. The tunic worn by princesses and important men reached down to the hands and the feet, but it probably had no sleeves.

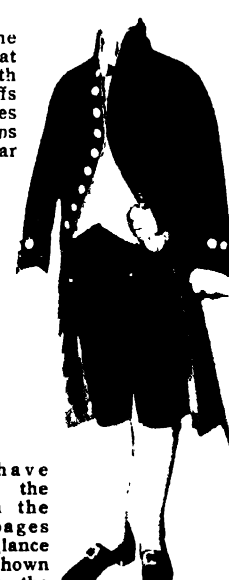
Now you may have noticed that so far we have heard nothing of sleeves. They were not unknown in the ancient world, but the climate did not demand them, and the style of clothing did not suggest them. How much simpler the dressmaker's art must have been! Nearly anyone could create a costume when all that was necessary was to run up the two side seams in the tunic. But for colder climates a toga is not so convenient. So when Julius Caesar first invaded Britain, he found there men who wore bright-colored coats that had sleeves and came down to the knee. Below that were loose trousers, and for a wrap there was a kind of cloak made of a square of bright-colored cloth that must have been a little like the Highland plaid. Red was one of their favorite colors, and the priests dressed in blue. The women's dresses came to their ankles, and on top they wore a kind of tunic, or long loose blouse.

It is easy to see why men in the north found trousers more convenient than the

WHERE OUR FASHIONS CAME FROM

The clothes on this page have all been worn by well-to-do people in Holland at one time or another.

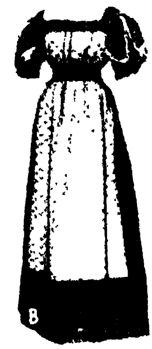
Though fashionable women everywhere have long taken their styles from Paris, there always are slight differences among the various countries.



The man just above at the left and the woman on the opposite side of the page are persons of the sort that Rembrandt, a famous Dutch artist of the seventeenth century, used to love to paint. Those stiff white ruffs frame many of his faces, and the good Dutch wives who sat for him were very likely to wear white caps similar to the one shown here. Dutch peasants wear them even to-day.

The two dresses in the left-hand corners of the page remind us of the demure costume adopted by the Quakers.

If you have looked at the costumes on the preceding pages you will know at a glance that the grand lady shown just above lived in the seventeenth century.

All the costumes on this page have been worn by Americans at one time or another. The gown at A was fashionable in 1845, the period of full skirts and crinolines.

B. The simple style of 1810. C. It was a seventeenth century lady who had to worry about these sleeves. D. A gown of the sixties, in Civil War days.


F. The early Puritans went to church in clothes like these. They spun and wove the goods themselves, and used only the soberest dyes.

G. A wrap worn in the twentieth century, when the outline, or "silhouette," of the costume is important.

E. A gown of the "gay nineties."

J An "empire" dress of 1810.



H. In 1855 the skirts were several yards around. I. A headdress of Revolutionary days, when middle-aged and elderly ladies always wore caps.

K. These hardy pioneers dressed in buckskin and homespun. But they laid the foundation for the wealth that makes it possible for Americans to spend more than any other nation on clothes.

*Photos by Metropolitan Museum of Art, A. S. Burbank, and Milwaukee Public Museum

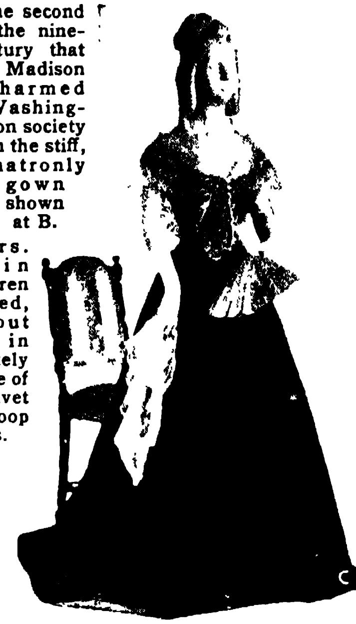
WHERE OUR FASHIONS CAME FROM

In staid array in their glass cases at the Smithsonian Institution in Washington are these gowns worn by the wives of the presidents of the United States.

A. In about 1800 Mrs. John Adams wore this simple but becoming blue gown when she presided over important functions.

It was in the second decade of the nineteenth century that pretty Dolly Madison charmed Washington society in the stiff, matronly gown shown at B.

C. Mrs. Martin Van Buren appeared, in about 1840, in this stately costume of blue velvet with hoop skirts.

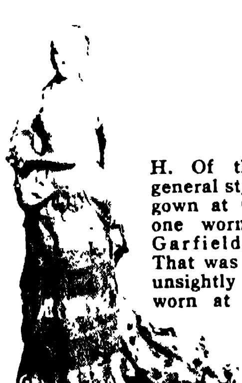


The blue brocaded gown worn by Mrs. James K. Polk sometime between 1845 and 1849.

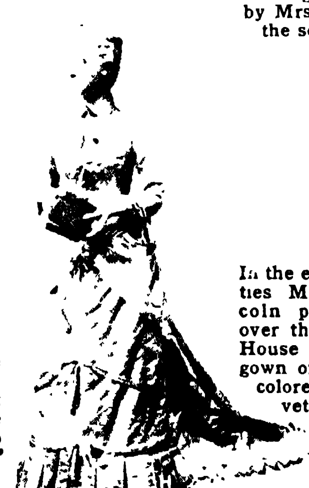
G. One of the ugliest periods of women's dress is represented by this gown of cream and gold brocade worn by Mrs. Rutherford B. Hayes in about 1880.

E. It was probably before the thirteen colonies had gained their independence that Martha Washington first appeared in this dress of salmon silk hand-painted with American insects and wild flowers.

F. A gown worn by Mrs. Grant in the seventies.



H. Of the same general style as the gown at G is this one worn by Mrs. Garfield in 1881. That was the day of the unsightly bustle, a pad worn at the back just below the waist to "improve" the figure.



In the early sixties Mrs. Lincoln presided over the White House in this gown of pansy-colored velvet (I).

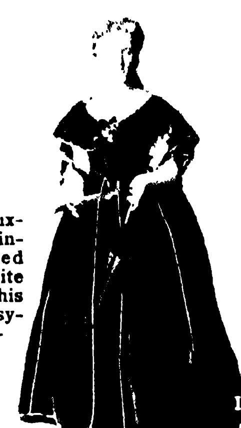
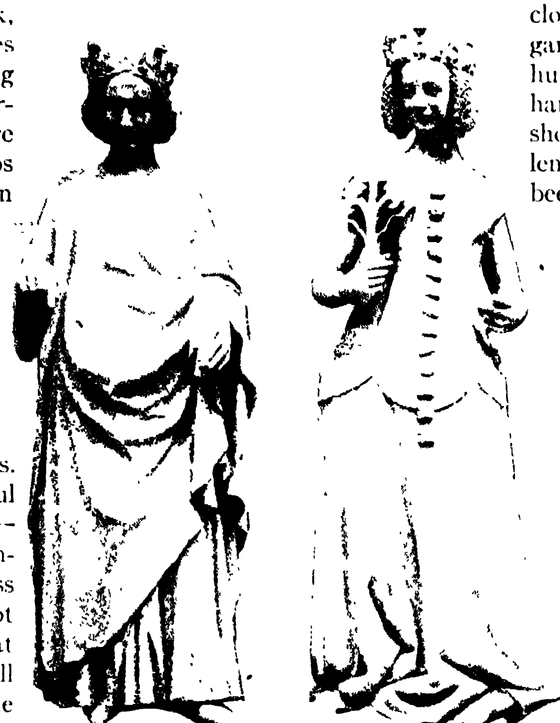


Photo by National Museum

flowing robes the people of the Mediterranean liked to wear. A toga would hardly be comfortable for wading through a snowdrift. In fact trousers for the north and skirts for the south used to be the general rule in ancient times, for both men and women. And even in our own day the women who do men's work, like working the mines in Belgium or tending the cattle in Switzerland, find trousers more convenient. Perhaps the women of northern climates would never have put off trousers if it had not been that their life came to be a sheltered one led largely indoors.



The lady at the left is still wearing the tunic and cloak of Creek and Roman days, though she is living in the Middle Ages. But before long there will come a change one of the great steps in the history of dress. The tunic will begin to fit the figure, and look like a modern dress. In the century after William the Conqueror landed in England women were wearing tightly laced bodices, like the one at the right, and both men and women arrayed themselves in two tunics and a cloak. It was from that uppermost tunic that the jacket and doublet finally developed.

The people of Gaul --the modern France-- dressed after the manner of the people across the Channel, and kept pretty much to that good old fashion well down into the Middle Ages. And of course the tunic and cloak were the fashion in southern countries long, long after the Roman rule had vanished from the earth. But as the toga was worn less and less, the tunic came to be more and more important. People decorated it with animals, landscapes, figures of men, and scenes from the Bible.

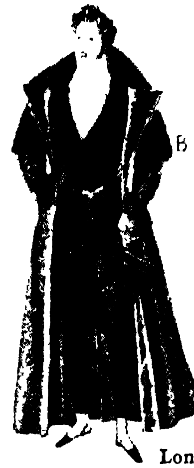
By the time when William the Conqueror was moving his throne across the Channel to the green island he had taken such a fancy to, both men and women were wearing two tunics, one long and one short, with a loose, togalike cloak for warmth; and on their legs the men had learned to wear tight hose that came well up. If their trousers were long, they bound them close with bands or garters from the knee down. Their black shoes did not come above the ankle, were pointed in front and sometimes behind, and the soles were often of wood.

But it was not long till smart folk began to see who could wear shoes with the longest points in front. So at the same time that cloaks and gowns began to trail, and sleeves hung way below the hands inside them, the shoes, too, took on a length that must have been a curse to the wearer. Certainly they brought curses in other ways, for the clergy said just what people who were vain enough to wear such monstrosities might expect to encounter in the world to come. But the good priests could not do much to curb a court that was bent on following a fashion. Shoes were turned way up at the toes, and twisted to look like ram's horns. It was said that the style was first invented by an unfortunate gentleman who had bunions. Finally parliament had to step in and pass a law to stop such foolishness.

When Tunics Were Made of Gold

As time went on the simple tunics of earlier days came to be laced and slashed and puffed and fitted in every imaginable way, and the cloaks took many shapes. The weavers and dyers had learned to do marvelous things, and rich fabrics—damasks, cloth of gold,

WHERE OUR FASHIONS CAME FROM

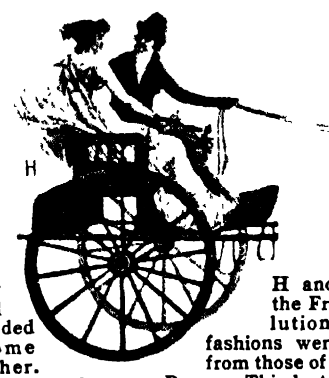


This is the way you would have looked if you had been a lady or gentleman living in Europe a century ago. At A and C are the fronts and backs of two gowns that show the beginning of the vogue for "crinolines," or full skirts held out by very stiff petticoats.

Long tight trousers have now become the fashion for gentlemen, and falderols of silk and lace and feathers are left for the ladies. But overcoats have skirts reaching to the ground.

The gentlemen at D and F have coats cut much as a full-dress coat is cut to-day. With it went an elaborate waistcoat and a frilled shirt. Before the century is very old those cocked hats will be exchanged for tall stiff hats somewhat like the silk hat of to-day.

E. These elegant creatures are wearing the tight stays that came in about 1830. Soon after that, skirts began to widen, and before long a fashionable lady would wear more than a dozen petticoats to hold out the white muslin dress that she wore to a ball.



Many a family prizes a colorful old shawl, handed down from some great-grandmother. One of them is shown at G.

H and I. After the French Revolution women's fashions were "copied" from those of Greece and Rome. This lasted till 1815.

silks studded with gems, and rare furs and laces—made the robes of both men and women gorgeous to behold.

When Tailored Clothes Came into Style

Of course those elaborate garments could not be made by running up a couple of seams, as in the Greek and Roman tunics. So now what we think of as "tailoring" appears at about the end of the thirteenth century—and clothes are fitted instead of being draped. Head-dresses too come to be marvelous and monstrous. Those amazing steeples and towers and turrets have been described elsewhere in these books. They were only a part of the richness and extravagance that people loved so much at the close of the Middle Ages and in the centuries that followed.

Of course the common people could not dress so wildly; they had to follow the fashion afar off. And luckily for everyone the styles did not change every season. When a man spent a fortune on a single suit, and loaded it with jewels, as often happened in the sixteenth and seventeenth centuries, he could hardly afford to discard it at the end of two or three months.

But such folly as this could not last. In 1666 Charles II, even though he was the "merrie monarch," announced to his court that he was going to adopt a fashion which he would never change again; and, strange as it may seem, he kept his word, and other men, in all the generations since, have followed the same general fashion that he set. It had to come if the country was to thrive, for the extravagance of earlier centuries would finally have ruined everyone.

Photo by Viet

Charles II, the "merrie monarch" who came to the English throne in 1660, is here shown with pretty Nell Gwyn, a famous actress of the day who was one of his favorites. This is the Charles who finally adopted a sensible costume and held to the style until his death. And from that style the dress of the modern man has been derived.

You will have no trouble guessing what Charles' new fashion was. But we will describe it to you in the words of the famous Pepys (pēps), who through those brave days kept the most famous of all diaries. "This day," he says on October 15, "the king begins to put on his vest, and I did see several persons in the House of Lords and Commons too, great courtiers, who are in it; being a long cassocke close to the body, of black cloth pinked with white silk under it, and a coat over it, and the legs ruffled with black ribband like a pigeon's leg . . . a very fine and handsome garment."

That was the coat and vest, which had originated in France and which, in one form or another, have been the fashion for men ever since. At first the breeches were short. It was not till the French Revolution, some century later, that the common people of Paris started the fashion for long trousers, by way of showing their contempt for the garb of the nobility. Indeed, short breeches are still a part of the court costume for men in England. But

WHERE OUR FASHIONS CAME FROM

No costumes in the world are more beautiful than the heavily embroidered silk robes of the Far East. Those at A and C are from China.

B. This charming Japanese baby wears a kimono, just as do his father and mother, and the other people in Japan.

The Japanese costumes at D and F are kimonos of heavy silk exquisitely embroidered in harmonious colors. With them is worn a sash that may sometimes cost a small fortune, so beautiful are its workmanship and materials. At E is a group of Japanese dramatic performers in costumes such as used to be worn in Japan when the country was ruled by armed knights.

The costumes at G, H, and I are all Chinese, and all of them very magnificent. Both men and women in China wear wide trousers and a long loose robe or jacket with high neck and loose sleeves. Over this, short wadded jackets may be put on for warmth. An official wears satin boots, and carries his pipe and fan in them. Poor people dress in cotton, but the wealthy wear silk.

Photos by Field Museum, Visual Education Service and American Red Cross

nothing has ever made men change entirely from Charles' sensible garb—"a comely and manly habit," said a writer of his day, adding that it surely was too good to last.

The wild extravagance of the past never came back. Gradually the men of other countries followed the sensible lead of Englishmen. To be sure, in the late seventeenth and the eighteenth centuries there was a foolish custom which demanded that everyone of standing, both young and old, must wear a powdered wig, with a three-cornered cocked hat on top of it. And at the same time women returned to the enormous hoop skirts which had been worn at the time of Queen Elizabeth—only in 1750 these grew so vast that a fashionable London house sometimes had its stairways built with balustrades curving outward, in order that the ladies might get upstairs. In another hundred years women were seized with the same madness all over again, and the period following 1830 saw hoop skirts as wide as any that had been worn a century before. What a pest they would be in a modern elevator or subway or street car!

Photos by Rischgitz, The Louvre, and Metropolitan Museum of Art

When good King Alfred ruled the land of England, men dressed much as did their king, who is shown in the topmost picture. By the middle of the seventeenth century, a long stride had been taken toward our modern dress, as you may see from the picture of Charles the First, in the center above. Another hundred years brought garments still more sober and comfortable, as is shown by the eighteenth century gentleman at the right. After the French Revolution, at the close of the century, trousers were lengthened, though they were still uncomfortably tight. But before long they grew looser—and then the final step had been taken in bringing our comfortable modern attire.

But just the same, everything was growing steadily more sober. The spread of democracy saw to that. A gaudy dress was no longer the mark of a gentleman. In the Middle Ages every class, every profession, every occupation had had its own special costume. We still may see monks and nuns dressed in the style that they chose at that time; and all the older lands have peasant costumes, beautiful and colorful affairs, that used to be worn by the people who tilled the soil. But as men came to stand on an equal footing before the law, they learned that it was vulgar to try to attract attention to themselves merely by wearing expensive clothes. To-day both men and women feel that good taste demands that they dress quietly on the street. And the fashion for men is so severe that the only place where they allow themselves much color is in their ties and scarfs or in sports attire.

Then, too, as the various nations of the world drew closer and closer together and came to know one another better, they no longer wanted to emphasize their differences, and so they stopped wearing their interesting but outlandish national costumes. To-day every fashionable man and woman tries to look like a citizen of the world, rather than of any particular nation. And so the well-to-do people of all modern nations dress alike.

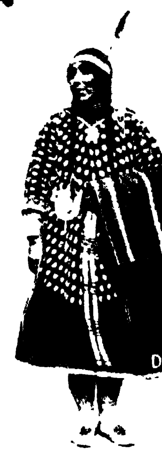
But who decides what that dress shall be? How are the styles made for us, and who agrees upon them? Now that is all very interesting, and in some ways rather complex. It may be said that until the 1930's a few French designers, called "couturiers" (kōō'tü'ryā'), decided what women should wear, and a few English gentlemen, with suggestions from their tailors, set the fashion for men.

This all began a long time ago. The French court for generations was the gayest and most brilliant in Europe, and French

Here are interesting costumes ranging all the way from the frozen north to the sands of the Sahara. Since these are simple people we shall expect to find them making their clothes of materials near at hand, and shall not be surprised to find that a Burmese native does not wear furs nor an Eskimo dress in silks and satins.

In a palm-strewn oasis of the Sahara stands the town of Biskra, a part of Algeria. There, amid groves of olives and orchards of pomegranates and apricots, are scattered little mud-walled houses; and there is the famous street of dancing and singing girls from the tribe of Walad-Nail. Two of them are shown at A, clad in the flowing costumes that we always think of as belonging to the Orient, and gay with bangles and innumerable other ornaments.

At B and D are two American Indians as they may be seen to-day in Yellowstone Park, dressed in the regalia handed down from their forefathers.



D. This squaw has decorated her costume with the modern substitute for wampum, which always consisted of polished shells of black or purple or white.

At E is a little Indian papoose all dressed up in her best; and at G is an Indian woman in the beautiful costume of the Dakotas.

The Eskimo woman at I and her little daughter at F are ready for winter.

C. A belle from distant Burma.

H. African natives dressed in their gayest and best.

Photos by D. C. B. & Q. Railway, Gramstorff Brothers, Museum of the American Indian, American Museum of Natural History, and National Museum.

Photo by B & O Railway

When the first American railroads were being built, along in the 1830's, the people who boarded the little trains dressed like this. That was the style in which old Uncle Sam was permanently arrayed.

taste and art have never been excelled in all these matters. The French have a gift for style. So the "latest thing" from Paris was always of great interest to women in every nation, for it was usually pretty. And whenever ambassadors or visiting noblemen went with their families to the French court, their wives and daughters bought themselves a whole new outfit as soon as possible, for they did not like to look behind the times. When they went home they took their new wardrobes with them. In this way the taste or whim of France came to rule Europe and America. But because American women lead much more varied lives than French women do, we have lately been turning to the work of American designers.

Now just as the art and delicacy of the French made them the best designers of clothes for women, so the dignity and restraint of the English taught them what was most fitting for men. And the men of the English court—the court of St. James, as it is called, from the name of the old palace where the court functions once were held—came to be the most powerful men in Europe, for the vastness of the British possessions and the weight of Britain's power gave them an influence which the men of weaker nations could not usually exert. So these were the men whose sensible, comfortable clothes were copied everywhere—and still are.

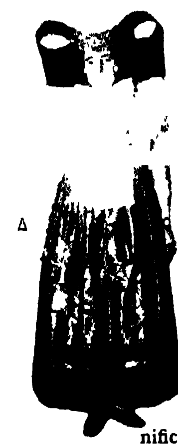
And yet, in spite of all that French designers and English tailors can do, it is the people themselves who finally make the styles they wear. Their habits, their tastes, their way of life shape the clothes in which people must appear. And the designers and tailors would starve if they tried to dictate fashions that their customers refused to follow or could not afford to buy.

Why the Styles Change

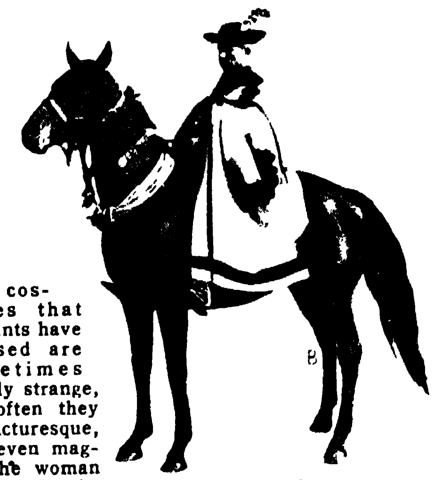
For of course to the designers and tailors it is all a stern matter of bread and butter. That is why the styles change every season—in order that fashionable people may have to buy new clothes from merchants who want to sell them. Then the rest of the world feels that it must follow suit, and so the business of manufacturing goods and garments and of selling them to the public all goes merrily on.

But if the designers and manufacturers stopped studying the tastes and needs of their public, the whole great industry would stand still. People are like sheep, it is true, but after all they can be driven only so far. They hate to spend their money for some-

WHERE OUR FASHIONS CAME FROM



A



B

The costumes that peasants have devised are sometimes merely strange, but often they are picturesque, and even magnificent. The woman at A is German, the cowboy at B is Hungarian, and the children at D are Dutch.

C

C and F show the height of peasant fashion in Czechoslovakia. At E is a Lithuanian lass.

G. An animated bolster from Czechoslovakia. H. Not a doll, but a very small citizen of the Swiss republic. I. A pair of peasants from Bavaria, in Germany. J. A German peasant girl.

G

H

I

J

thing they do not like and will never want to wear. So because of all this, dress has kept pace with the fast wheels of progress.

Only think for a moment of the change that has come about in the lives of women since the opening of the twentieth century and you will see why they wear the comfortable, practical clothes that are in fashion to-day. Less than half a century ago, women were deforming their bodies in just about the way in which certain very primitive peoples did. They were drawing in their waists like a wasp's, were piercing their ears for rings, were torturing their feet in shoes several sizes too small, and were choking themselves with high collars that left raw spots wherever they rubbed. Anything more hideous and deformed than some of those old fashions it would be hard to imagine. Is it any wonder that it was ladylike to faint in an age when no fashionable woman could, by any accident, take a good deep breath?

But then women began to be real people. Girls went to college and began to work at something besides sewing and a little embroidery. It was no longer a disgrace for them to earn a living. And at the same time they began to leave off their torturing corsets, their uncomfortable collars, and their yards and yards of trailing skirt--one of the most efficient germ collectors the world has ever seen. Every time they entered a new sphere, they bought themselves suitable clothes for it. They took up golf and tennis, motoring, the airplane, and mountain climbing. They are doctors and lawyers and public officials; they operate thriving businesses and direct big philanthropic enterprises. Needless to say, fainting has had to go out of style--but the clothes that caused it had to go out of style first. To-day women's dress is probably as beautiful and sensible as it has ever been in the history of civilization.

Now it is interesting that not long ago the French designers decided to turn back the clock of time. The manufacturers of yard goods were complaining that the new, comfortable styles did not take enough cloth, and the corset makers said that if women kept on being comfortable the corset business would be ruined, and the makers of gloves said it was a scandal for women to appear in evening dress without having their arms sheathed in leather right up to the shoulders.

So all of a sudden, women were told that they must wear yards of skirt that reached clear to the ground, that they must lace themselves into snug corsets, and never appear in public without gloves. Styles were to be very "feminine"--or, in other words, like the styles of a long time ago, when women were exhausted if they walked half a mile.

But right at that moment it was proved for good and all that it is the people themselves who make the fashions. Women said that they could not possibly drive an automobile with all those yards of cloth around their legs, and that the new-style corsets were an invention of Satan. They managed to get along with the clothes that were hanging in their closets, and by another season the designers had learned their lesson and were willing to sell their customers clothes that were more sensible and comfortable.

So remember, whenever you go to buy shoes or a coat or a hat, that your choice is helping to create that great, vague thing that we know as "Fashion." Never allow a manufacturer or salesman to impose on you with something that is ugly or silly. He is doing it solely for his own profit, and you are under no sort of obligation to fall in with his schemes. Instead, it is your duty and privilege to help make the clothes of your own generation the most beautiful and fitting that the world has ever seen.

COSTUME

(1) c. 1610-1625 c. 1585-1615

(2) c. 1625-1640 c. 1650-1660

(4) c. 1780-1790

(3) c. 1735-1750

(5) c. 1794-1800

(7) c. 1876-1882

(6) c. 1845-1855

(1) (2) (3) Aristocrats in formal attire when French and Dutch styles prevailed throughout Europe and America. (4) House dress or traveling costume, a favorite style of Marie Antoinette's time. (5) An *Incroyable* and a *Marveilleuse*, extreme modes of the Directoire period. (6) Riding habits of the early Victorian era. (7) Formal day and afternoon gown of the bustle period. (8) Evening or formal dress, mid-20th century.

(8) c. 1950

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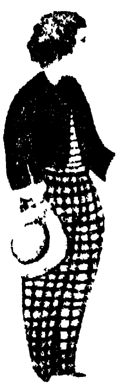
Plate 1

COSTUME

(2) c. 1570-1588

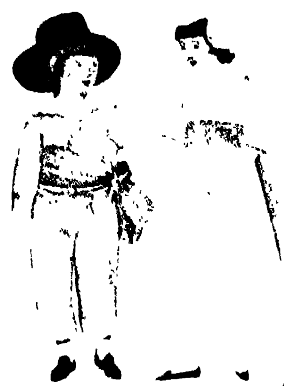
(1) c. 1200-1300

(3) c. 1655-1670



(6) c. 1840-1860

(4) c. 1730-1745

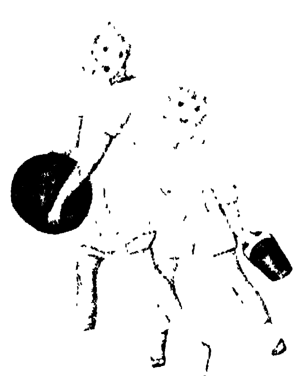


(5) c. 1775-1790

(7) c. 1850-1865

Children were dressed like their parents until late 18th century (1) (2) (3) (4). From stiff formal styles (4) there was a sudden change to simplicity (5). The Victorian age again brought tight adult styles (6) (7). Since 1910 children's clothes have been designed particularly for children.

(8) c. 1890-1910



(9) c. 1925-1930

(10) c. 1950

Plate 2

Reading Unit No. 2

GREAT "KING COTTON"

Note: For basic information not found on this page, consult the general Index, Vol. 15.

For statistical and current facts, consult the Richards Year Book Index.

Interesting Facts Explained

Cotton spinning in ancient times, 9–27
Climate necessary for growing cotton, 9–27-28
The world cotton crop, 9–28
What most of the world's clothing is made of, 9–28
Two hundred varieties of cotton, 9–28
The cotton-growing season, 9–32
Enemies of the cotton plant, 9–33
Spinning and weaving, 9–34

Things to Think About

How has cotton changed the history of the world?
Which countries grow cotton?
Why are gulf and sea-island cotton the most valuable?
How are cotton plant pests destroyed?

Picture Hunt

How is cotton grown? 9–26, 28, 32
How is cotton spun and woven? 9–30-31

Related Material

How do insects make sounds? 3–292, 337, 345-49, 372
How do insects breathe? 3–274
How is cotton used to make rayon? 9–86
How does cotton compare with wool? 14–550
How was cotton used in ancient times? 9–27, 10–403
How is oil obtained from cotton? 9–312
How does the cotton gin clean cotton? 10–404-7
How are explosives made from cotton? 10–417

Practical Applications

How is cotton thread manufactured? 9–30
How is cotton thread made into cloth? 9–31

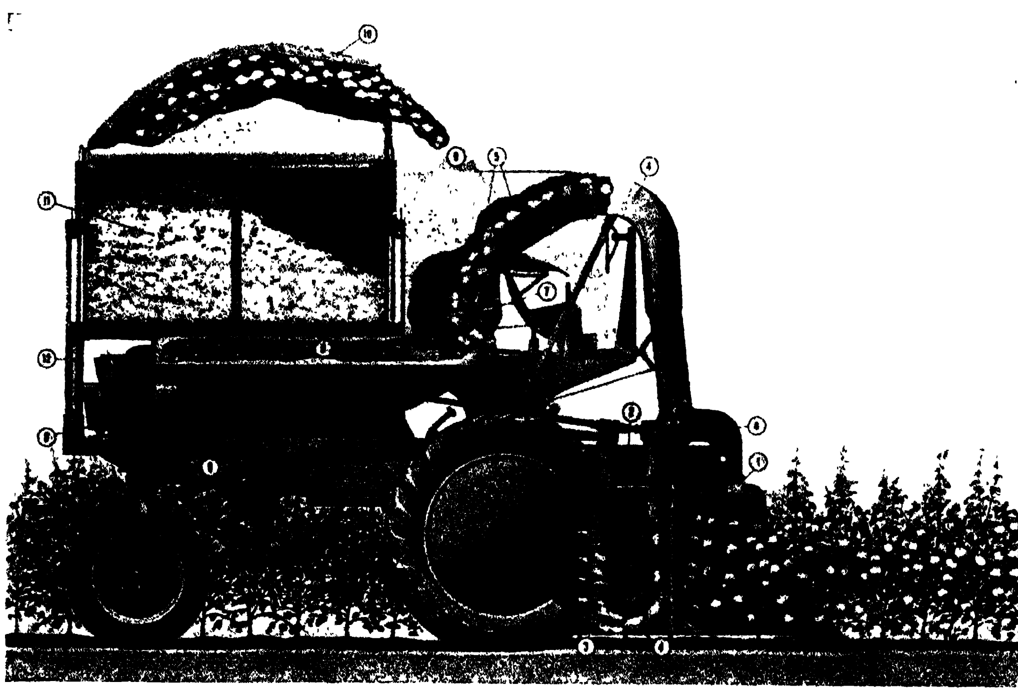
Leisure-time Activities

PROJECT NO. 1: Spin some thread from a piece of fluffy cotton, 9–46.

PROJECT NO. 2: Weave some cotton cloth, 10–342.

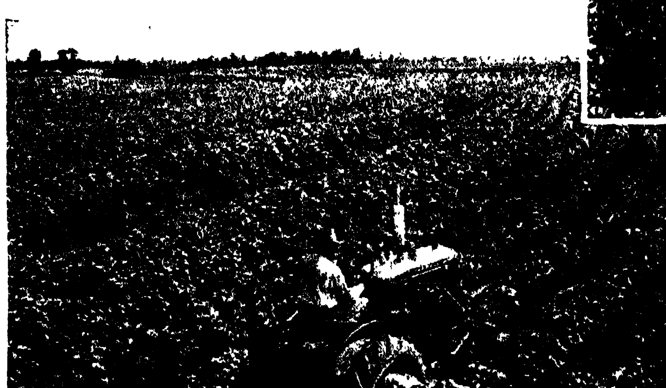
Summary Statement

Cotton supplies man with ninety percent of his clothing. The loss of one cotton crop would bring hard times.



The slow, back-breaking toil of picking cotton will eventually be done away with by the mechanical cotton picker. Above, you may see how it works. First, barbed spindles at 1 and 2 pick the cotton from each side of the plant. At 3 it is removed from the spindles and drops down to the air conveyor at 4. This blast of air carries it to the grates, 5, where dirt and trash are blown out by air from a vacuum fan, 6. From the grates the cotton passes to a rotating device, 7. This sends it to an air blast conveyor, 9, set in motion by the blast fan at 8. The blast carries the cotton against the grates at 10 for a final cleaning before it goes into the basket, 11. At the edge of the cotton field hydraulic cylinders, 12, will tilt the basket to unload the cotton into waiting vehicles.

At the right you see the cotton picker at work in the field.



Photos by International Harvester Co.

The farmer at the left is cultivating his cotton by machine. He has been wise enough to contour (kŏn-tōōr′) the field—that is, to plant the rows across the slopes of the land instead of up and down hill. This keeps the water from washing out the soil along the furrows. The use of machinery in the cotton fields is expected to work a revolution in the South, for it enables one farmer to do the work of five men. He will make more money, his cheaper cotton can once again compete in the world market, and labor will be freed to work in Southern industry.

A Study in Black and White.

In the sunny South the children, as soon as they can carry a basket, begin to work all day in the cotton fields.

Photo by Carlsbad, N. M., C. of C.

GREAT "KING COTTON"

Out of His Fields of Summer Snow Have Come Half of the Clothes of the World and a Good Deal of Its History

CAN you believe that any man could stand and look at cotton growing in a field one morning and then put on a suit of clothes made out of that very cotton the same evening? Well, it can be done, and has been done. About fifty years ago, in 1881, at the Cotton Exposition in Atlanta, the Governor of Georgia appeared one evening in a fine suit of clothes made out of cotton that had been growing in the field that very morning. And since then that record has been broken many times.

Such is the marvel of the newest machinery, at work on one of the oldest of man's crops. And it is about this rich crop and the machines to handle it that we are now going to talk a little.

Nobody knows when cotton was first used to make clothes. In India and in Egypt it was spun into thread and woven into cloth thousands of years ago. In Rome it was used to make tents for the great army of Julius Caesar. In Peru and Mexico the Indians were wearing cotton when the Spaniards first found them there, and for many a century they had been wrapping the bodies of their dead in cotton cloth for burial. So the use of it is very old and very widespread; and in our story about spinning and weaving we have told of all the ways that men have known of making cotton into cloth.

Cotton will grow only in warm countries. It is now grown in nearly every warm land on both sides of the Equator. From the very first it has been the great crop of our southern states, which supply more cotton than any other country in the world. After them comes India, with China, Egypt, and

Photo courtesy Dan River Mills

These are the people who pick the great fields that spread their snowy cotton over thousands of acres in the United States. The harvesters say they "black a strip" when they pick off the white bolls which make a cotton field bright, and leave the plants bare.

Brazil; and a great deal of cotton is also grown in Russia, Mexico, and Peru. The crop of the whole world is staggering to think of. All together it weighs many billions of pounds—and if we remember how light and fluffy cotton is, we know what a pile this would make!

In the old, poetic plantation days, the vast fields of the South were busy places, and in spite of the hot work, they were often merry. Cotton and sugar cane and tobacco were almost the only crops grown there, and the plantations often covered thousands of acres. The work was all done by the dusky slaves who lived in clusters of little cabins around the mansions of their owners, the great planters. In the day the darkies toiled "in the cotton and the cane" and in the evening they often gathered in groups to play the "old banjo" and to sing the sad, sweet songs that have now become so famous as plantation melodies and "Negro spirituals." Some of the most popular songs in the world have come down to us from the old days of the cotton fields.

Cotton Is Still Called King

And in many ways it is still about the same all through the Southland. The Negroes are now free, but they still pick cotton and they still sing as of old. The plantations are far smaller, and so is the crop. But it still is called "King Cotton," though the farmers are now experimenting with a greater variety of crops. Probably the cotton-picking machines now on the market will eventually make it profitable for the farmers to plant more cotton again. Most of the clothing the world wears is made of cotton. If the world crop were to fail we should have a bad time.

Now what is this priceless plant that we call cotton? It is one of the mallow family, and is a cousin to the marshmallow and the hollyhock. There are nearly two hundred different kinds of cotton, though only very few are widely grown. In the upland fields the plants of "staple" cotton grow three or four feet high. Gulf cotton, along the Gulf of Mexico, grows a little higher. In Peru the cotton plants may get to be ten feet tall, and on the islands off the coast of South Carolina and Georgia they will grow to twelve feet

INTERESTING FACTS ABOUT COTTON

Cotton fiber spins easily into yarn because it is not perfectly straight; it is really a thin flattened tube that is loosely turned but not tightly curled. If you looked at it under the microscope you might compare it to a corkscrew which had been somewhat drawn out in length. The twists make one fiber cling to another when they are spun, and the strength of the yarn depends on the various fibers' clinging together in this fashion to form one smooth thread.

Wool fiber is not so smooth on the surface as cotton is. Tiny cells, overlapping like the scales on a fir cone, form slant ridges on the outside. The fiber is crinkly and has much tighter curls than cotton has. So it is more elastic than cotton or silk and even more suitable for spinning, for the wool fibers do not slip. In finer woolens the crimps are very numerous and close together. Because of these many crinkly fibers a woolen fabric is full of tiny air spaces that allow of a free circulation of air, so that moisture is less likely to gather on the skin of a person wearing the cloth. But more than that, the air spaces help to keep the wearer warm, for like a dead-air space in a wall they keep the cold out and the heat in.

Much of the cotton used for the world's clothing comes from the warm, fertile lands of the United States, where the abundant crop and machine labor makes the cost of the raw fiber very low. Great Britain is one of our heaviest buyers, though since World War I her former position as leader in the making of cotton cloth has been challenged by the United States. For many years her mills set an example to the whole world in turning the woolly balls into the materials that are so necessary in our homes. Manchester and neighboring cities in England produce every variety of plain cotton cloth, such as batiste (bȧ-tēst′), cambric, muslin, lawn, voile; many kinds of "fustian" (fŭs′chăn), such as corduroy, moleskin, and velveteen; dress materials, such as piqué (pê-kā′), poplin, gingham, dimity, and sateen; materials used in upholstery, such as cretonne and chintz; and a wide variety of other fabrics—some coarser and some more delicate—such as flannelette and artificial silk. It was an Englishman, John Mercer (1791–1866), who introduced the process known as "mercerizing," whereby cotton is treated with a solution of caustic alkali to make it take the dye better. If the cotton cloth or fiber is stretched during the process it takes on a silky look.

The United States uses its best cotton in its mills at home. The Egyptian cotton that it imports—the very finest in the world—is for use in knit goods. The cheapest fibers raised in the South are exported to China and Japan, or are woven at home into coarse cotton sheeting and uncolored cloth which the poorer people of China and Africa are glad to buy for very little money. For home use cheap cotton cloth is often printed with a colored pattern to make the familiar "calico" of kitchen aprons and similar garments. For many years New England led the country in manufacturing cotton cloth, and she still produces most of the more delicate fabrics made in America. Philadelphia has become another important center for cotton weaving, especially for tapestries and chenilles (shē-nēl′)—goods made of a kind of tufted cord—or fabrics that require great skill in dyeing. She also specializes in machine-made lace, hosiery, and knit goods. Lately the South has come to rival New England itself in the production of certain kinds of cotton cloth.

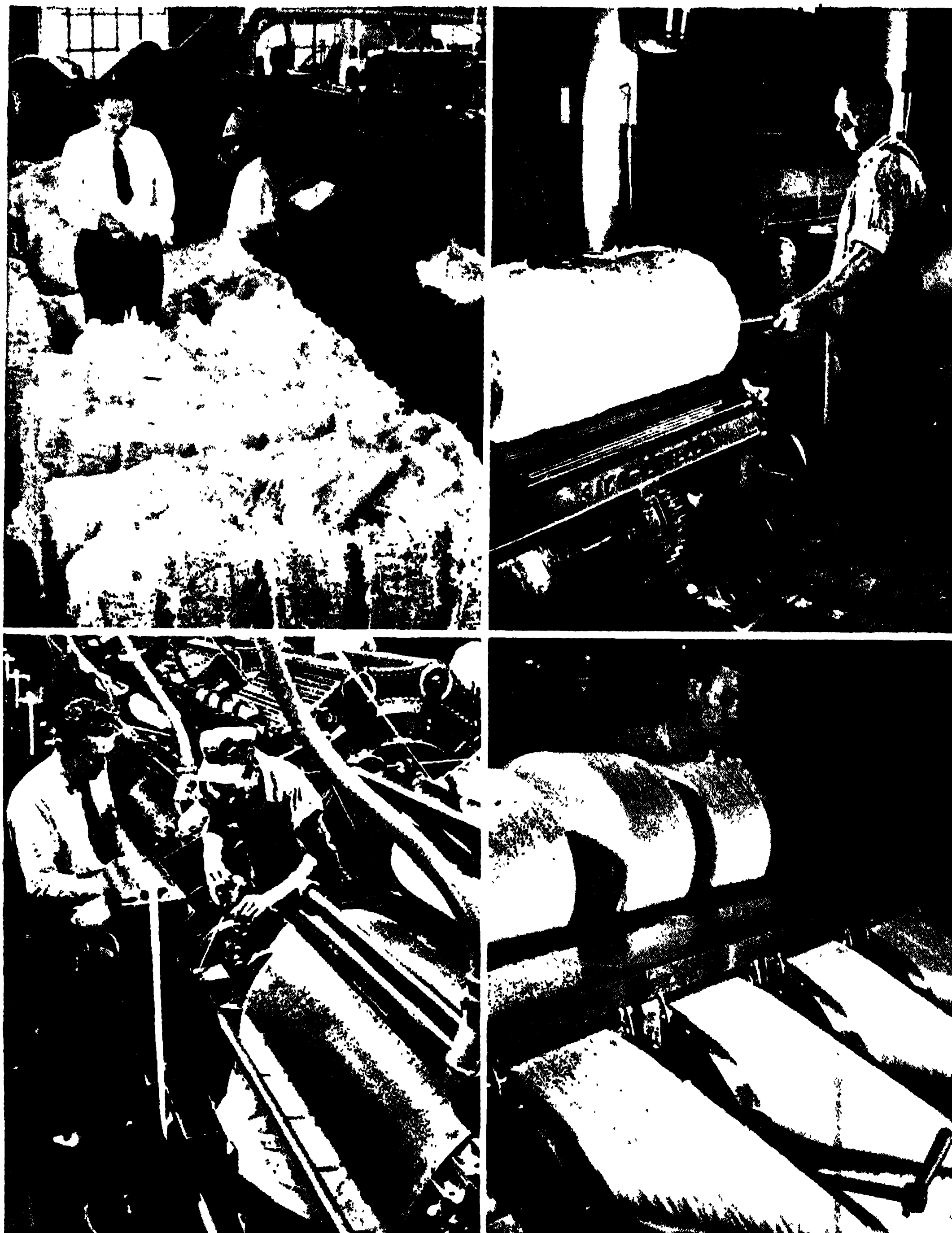
Other countries, especially Brazil, are doing all in their power to encourage cotton weaving. Brazil manufactures most of the fabrics used at home and exports material to Argentina, Uruguay, and Paraguay. Japan too makes a great deal of cheap cotton goods. It is probable that India, Japan, and China will develop the industry more and more in the years to come, for labor in those countries is very cheap. In general Europe manufactures the coarser materials for its own use, though Northeastern France and the manufacturing towns of the Rhine Valley produce some fine cotton cloth and thread. Of course cotton thread and twine are made in many places.

It is interesting that more and more cotton is used in industry as time passes. This is especially true in the United States, where much of our cotton is made into goods used in manufacturing, building, transportation, and other industries. In this country alone cotton goods are put to over a thousand uses. They are made into bags for shipping goods; they are used in upholstering automobiles; the tires on which we ride depend upon cotton for their strength; it binds our books; it wraps cheese and meat and other foods; it is woven into sails and tarpaulins, and belts that help to drive machinery; and it is often called upon when houses are built. No wonder such a large number of the farms in the United States are growing the little white balls.

A great many things depend upon the cotton crop. It was our country's chief export for more than a century, and has often been called "the barometer of world trade." For if the crop is good and the price is high business in general is likely to be good. The return from it makes up a large part of the total income of farmers in the United States, and the growing and manufacturing of it give employment to many millions of people in our country. It yields our farmers far more cash than any other crop does, and on many of the farms in the South it is the chief crop.

But more than that, the size of the crop and its price influence the prosperity of countless other industries—the manufacture of farm implements, steel, lumber, shoes, radios, furniture, automobiles. For when the returns from the crop are satisfactory all the people who help to grow or manufacture cotton are able to spend more money for the necessities and luxuries that the industries of our busy country supply. Indirectly this affects the business of railroads, shipping lines, banks, and insurance companies. Foreign exchange rates—that is, the amount our money is worth in terms of foreign moneys—may rise or fall as the price of cotton rises or falls. So it is easy to see how important the world cotton crop is, and especially the cotton crop of the United States, since we produce such a large part of the world's cotton.

Since so much depends upon the size and quality of the cotton crop the Department of Agriculture watches its growth carefully. From the time the little cotton plants first spring up until the new crop goes to the gin the government issues bulletins as to the condition of the plants and the probable yield. Growers, buyers, and sellers all over the world eagerly study these reports, for prices are greatly influenced by them. Cotton, you see, is bought and sold all through the year, not just when each new crop is ready, and in years when the price is low the dealers sometimes hold the cotton for a long time, until it is needed and the prices have risen. Buying and selling would be quite simple if everyone could go to the farmers' markets and look at the cotton before they bought it. And it is true that some cotton is bought in this way. Such markets are called "spot markets," and the cotton "spot cotton." But a firm in Manchester, England, can hardly come and look at the cotton in a little market in Alabama or Tennessee; so "cotton exchanges" have been set up, where cotton can be bought and sold for future dates as well as for the present.



Photos courtesy Reeves Brothers

Here you can see the wonderful machines that turn raw cotton fibers into cloth. At the top left is the opening room of a mill, where the cotton is loosened by beating and foreign matter is sucked out. The cotton stock is then made into a "lap," or loose roll, such as you see at the top right. A carding machine gathers up the long fibers of the lap into a fleecy "sliver," or slender roll, which is coiled in cans as it comes from machines like the one shown at the lower left. If this sliver is then passed through a sliver-lap machine, it will look like the rolls of cotton on the ribbon lap machine shown at the lower right. The ribbon lapping process makes four laps into one, in order to give greater evenness to the parallel fibers.

Photo courtesy Reeves Brothers

The combing machine at the top left removes the short fibers of cotton and combines eight laps again into a sliver – smoother and more lustrous than before. This sliver is ready for drawing, the process going on in the photo at the top right. The sliver is pulled ever finer and given a slight twist before it is wound on bobbins. Next the bobbins are put on a spinning frame, such as you see at the bottom left, where the yarn is drawn and twisted hard and firm before it is re-wound on bobbins. Finally, thousands of threads are transferred to a long roll called a "beam." Other threads are shuttled back and forth through the beam threads to produce woven cloth. This is what is being done by the machine at the bottom right.

Photo Copyright by Milwaukee Public Museum

No plant that grows has changed the history of the world as cotton has. When England, who manufactures more of it than any other country, began to build cotton mills, she forged ahead into one of the greatest manufacturing nations of the world. And when the United States, who grows more cotton than any other nation, began to raise it on her great plantations, she enslaved a race to work them for her, and so brought on one of the worst of all civil wars. Above is a painting of a cotton plantation of those days showing the Negro field slaves, glistening with perspiration, bringing their cotton to have it "weighed in."

All these plants are raised from seed sown every year. But in India there are cotton trees that keep living from year to year, and yielding an annual crop. They grow as high as twenty feet.

Where the Cotton Blossoms Bloom

"Away down south in the land of cotton" there is a beautiful sight every June when the cotton blossoms come. For the first day they are snow white. The next day they will turn pink. A few days later the petals drop off and leave a little green pod. The pod gradually swells until it gets to be about the size of an egg. Then it bursts open and displays a fluffy white ball. This is the cotton—a mass of fibers clinging around seeds about the size of orange pits.

The blossoms do not come all at the same time, but keep it up all summer. The first pods, or "bolls," as we call them, burst in July, and the last ones in November. So there is work for some four months picking a field over and over again.

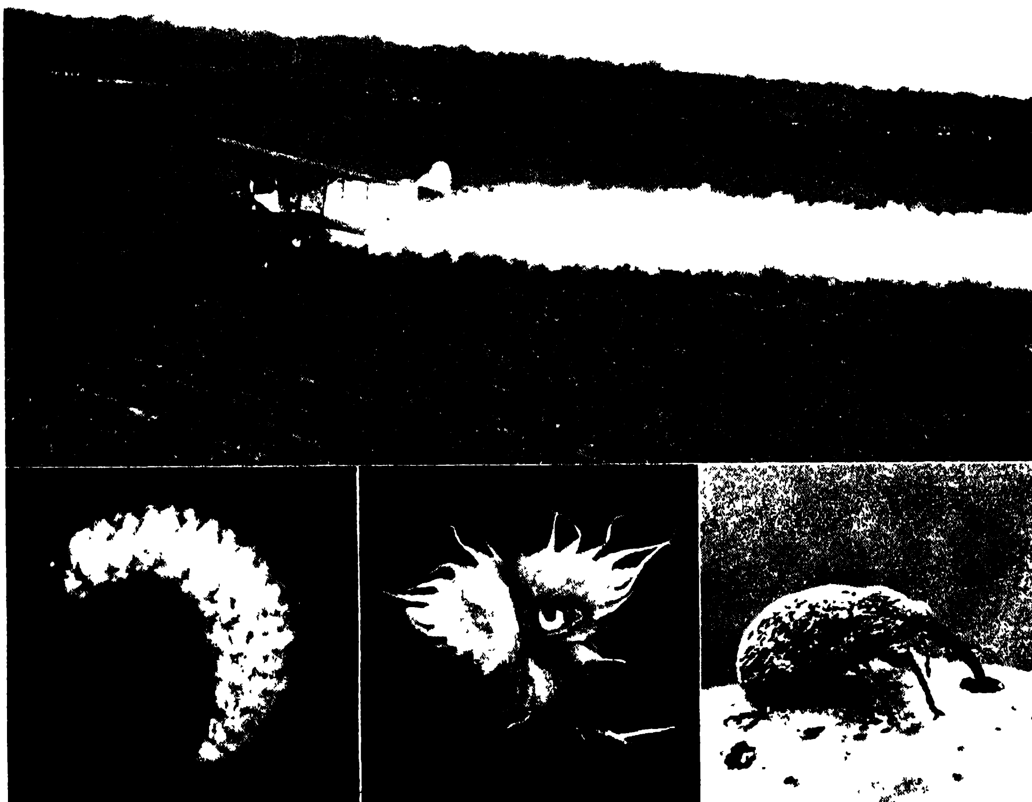
The cotton that we pick varies greatly according to the kind of plant we are growing. The color differs; most of the upland cotton is white, but that of the sea islands is creamy, while that in Peru is reddish and some of the crop in Egypt is brown. It also differs in quality. The cotton from Peru is coarse and hairy, and so is greatly used for mixing with wool in making felt and coarse cloth. Other cottons are finer, and the best are very fine and silken indeed.

Where the Best Cotton Grows

Most of all, the cotton varies in the length of its fiber. The vast crop of upland cotton has a relatively short fiber, and is therefore called "staple." Gulf cotton has a somewhat longer fiber, and sea-island cotton much the longest fiber of all. It is therefore the best cotton in the world, for the long fibers make the finest thread and cloth. A pound of sea-island cotton can be spun into a thread a hundred and fifty miles long.

GREAT "KING COTTON'

The cotton plant has its enemies, like every other plant or animal. Just as the potato is attacked by the Colorado beetle, which we call the "potato bug," corn by the corn borer, and wheat by the chinch bug, so cotton has its foe in the boll weevil. This



Photos by U. S. Department of Agriculture

Uncle Sam has to call out his airmen to help fight the demon of the cotton fields. Directed by the Chemical Warfare Service, they sprinkle the boll weevil with tons of powder that deal him certain death. Figures 1 and 2 show the young weevil in the larva or worm stage of his development. At this time he feeds on the cotton seeds and linters. The ugly monster in Figure 3 is a much-enlarged view of a full-grown weevil that is making a hole in the boll with her beak. In that hole she will lay an egg from which the worm will hatch.

is a little brownish beetle that punctures the boll with its beak and lays its eggs inside. The young insects then eat up all the cotton.

How We Fight the Boll Weevil

The boll weevil came to us from Mexico. In 1921 and 1922 the little beast did enormous damage to the cotton—so much that in 1921 we grew only eight million bales of cotton, as against thirteen million in the year before. That is what the little pest cost us. But we have found ways of fighting him, and both the national and state governments have declared war on him. By 1926 he was under such control that our crop was the largest ever grown up to that time—eighteen million bales.

Yet the boll weevil is by no means gone, and we have to spend enormous sums to fight him every year. Luckily he has not spread all through the cotton belt; he is at his worst in Texas. The best way we have of making war on him is to sprinkle the cotton plants with some poison like calcium arsenate (kăl'sĭ-ŭm ar'sē-nāt). This is done with machines, or by airplanes flying low over the cotton fields. When the dust settles on the plants it poisons the weevil. We now sprinkle hundreds of thousands of acres of cotton fields in this way every year.

Another foe to cotton is the little bollworm. This is quite a different creature. The only way we know so far to get the best of him is to starve him. And the only way we have to starve him is to plant no cotton for several years in any region where he has appeared. Then he has nothing to eat. Lately we have learned that the grubs of a certain wasp eat up the bollworm grubs. So those wasps are let loose in the fields.

From Cotton to Cloth

When we have saved our vast cotton crop to ripen in the fields, of course it is still only a little way on the long road it has to travel before it turns into clothes to be put on our backs. Most of what happens to it on that road we have told in our stories about the cotton gin and about spinning and weaving. And now if you will look at the pictures you will see nearly all the rest with your own eyes.

You will see how it is picked by hand all through the hot season. Two or three hundred pounds is a good day's picking for an able man. Of course the new machines plant, thin, weed, cultivate, and pick the crop.

After it is picked the cotton goes to the gin, where it is separated from the seeds. This used to be so hard to do by hand that a man could gin only about a pound a day. Now a great machine will gin several thousand pounds in the same time, and clean it as well.

The seed that is left is useful, too. In the old days it was just thrown away. Now the fibers, or linters, that cling to the seeds are used to stuff mattresses, are made into surgical dressings, go into explosives, or are turned into rayon, cellophane, paints, or various plastics. The cottonseed oil, which is pressed from the seeds, goes into soap, salad oil, margarine, and cooking fat. And what is left of the seed when the oil is removed makes excellent food for live stock. These by-products of cotton, once wasted, are worth hundreds of millions of dollars.

In the pictures you will see the cotton sifted and fanned after ginning, to clear away dust, and then packed by powerful presses into bales, which are covered with burlap and bound with iron bands. In these bales, weighing from five hundred to seven hundred pounds, it is shipped off to the factories. In the old days there were no factories in the South, and the cotton all went to the mills in New England or across the water. Now the South is full of cotton mills, and a large part of the crop is made into cloth right at home.

In the pictures you will finally see all that happens to the cotton at the mill. It goes through a great many processes, as you will note, but they all end in spinning the fiber into millions of threads and weaving the threads into miles of cloth. It is the old, old story, known along the Nile thousands of years ago, where they spun thread and wove cloth just as we do. The difference is that with our machines we can do it thousands of times faster. In the single town of Fall River, in Massachusetts, we can turn out four miles of cloth every minute.

America's First Cotton Mill

The first cotton mill in America dates from 1790. It was built in Rhode Island, by Samuel Slater. For some twenty years there were not many more, and we kept on getting nearly all our cloth from England. Then the War of 1812 stopped our sending cotton to the English and getting back our cloth from them; and we began to build our own mills in earnest. In 1805 we had only 4,500 spindles at work on this side of the water, but twenty years later we had 800,000. By the time of the Civil War we had about 5,000,000. Now we have tens of millions.

Of course we always raise more cotton than we can use, and most of what is left over we sell to other lands. We grow some 9,000,000 bales a year and export sometimes a third of them. We import a little too under 400,000 bales. This is in order to get certain kinds of cotton that we do not grow at home.

In all warm climates, and in every hot season, cotton is better to wear than wool. In the cold weather wool is preferable because it is so much warmer.

The STORY *of* SILK

Reading Unit
No. 3

THE WEALTH OF THE SILKWORM

Note: For basic information not found on this page, consult the general Index, Vol. 15.

For statistical and current facts, consult the Richards Year Book Index.

Interesting Facts Explained

Legends dealing with the origin of silk, 9–36-37
How silk came to us from the East, 9–37
The silkworm, 9–38-39
Centers of silk production, 9–37-38
The silkworm's mother, 9–39-40
Silk thread, 9–42-43
Feeding silkworms, 9–40
Weighted silks, 9–43

Things to Think About

What is the difference between silk and tussur silk products?
Why are weighted silks not so good as pure silks?
Why did the Chinese make death the penalty for exporting silkworms?
Why are no silkworms raised in the United States?

Picture Hunt

How are silkworm eggs hatched? 9–41
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How is silk removed from the cocoon? 9–42
How are silk fibers made into thread? 9–43

Related Material

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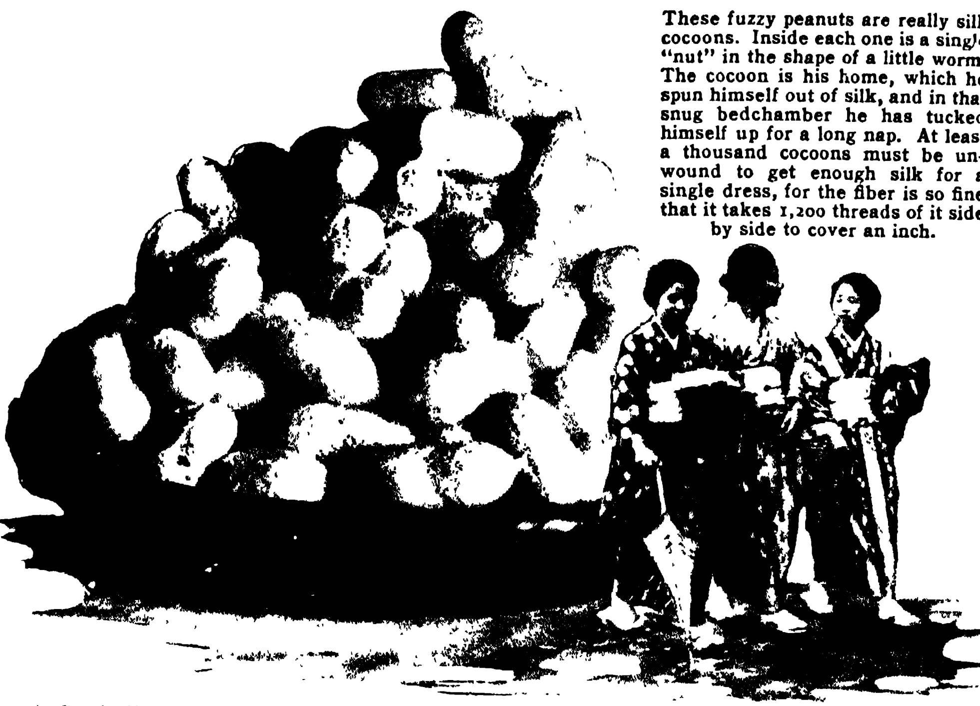
How are silk rugs woven? 12–150
How is silk made without the use of the silkworm? 9–83-86
How are tapestries woven? 12–138
How is silk used in Japanese costumes? 5–344
How is thread spun by machine? 10–339
How is silk dyed? 9–304-6
What are some of the costumes worn in China? 9–19

Practical Applications

How is the cocoon of a moth made into silk? 9–40
How is waste prevented in the production of silk? 9–43-44

Summary Statement

The cocoon of the silkworm provides us with the fiber for spinning and weaving silk—the finest material for clothing.



These fuzzy peanuts are really silk cocoons. Inside each one is a single "nut" in the shape of a little worm. The cocoon is his home, which he spun himself out of silk, and in that snug bedchamber he has tucked himself up for a long nap. At least a thousand cocoons must be unwound to get enough silk for a single dress, for the fiber is so fine that it takes 1,200 threads of it side by side to cover an inch.

Photos by Cornelia Clarke and Japanese Consulate

The WEALTH *of the* SILKWORM

There Are No Clothes So Fine as Those We Steal from Him in His Sleep

HERE is the story that the Chinese tell about the way silk came into the world. It is not quite true, as we shall see, but it is such an old story that we ought to begin with it.

About 4,600 years ago there was a little Chinese princess named Liu Tsu (lē-ōō' dzōō), who at the age of fourteen became a queen by marrying the emperor Huang-Ti. In those days even a queen was expected to do some useful work, and Liu Tsu, now Queen Si-Ling-Chi (sē-lĭng-jē), wondered whether she could not do something very valuable with the fine threads that were spun in their cocoons by the silkworms that she used to watch at their work in her native land. The threads were so fine and strong and glossy that if she could only unwind them and weave them she would have the most beautiful cloth the world had ever seen.

So she watched and watched the silkworms, and worked and worked over their cocoons, until she found a way to unwind the delicate threads that they spun round and round themselves. Then the rest was easy, for everybody knew how to weave any sort of thread into cloth. And so the queen gave the world its silk, and grew very famous. She was even made into a goddess, and for the Chinese she remains one to this day.

Now very few stories as old as this are exactly true, for they were all made up when people were still rather ignorant but very full of fancies. As you will see before we are through, no single person would be very likely to find out all we need to know before we can make silk out of the threads of the silkworm; and surely a great many people must have worked at the puzzle before the days of the queen who grew famous for her interest in it. But nearly every old story also has a grain of truth in it, for there must

have been something to start it; and probably the truth is that Si-Ling-Chi gave a great deal of help to all the people who were trying to make silk.

How Silk Came Out of the East

At any rate, the Chinese had found out how to make silk as long ago as her time. The silk soon began to find its way out of their land into other countries, where it was highly prized. It came into India and Persia, and finally into Greece and Rome. When it first began to appear there, before the time of Alexander the Great, it was literally worth its weight in gold, for it had traveled a long way; and for many a century it was going to remain a most expensive article

For although the Chinese sent out silk to other lands, they never told anyone how to make it. They kept their valuable discovery a secret, and they even had laws that would put any man to death if he carried out of the country any of the silkworms that spun the thread, or of the eggs that grow into silkworms, or any seeds of the mulberry tree on which the silkworms fed. So for a good while after the other people in the world had a little silk, they did not know that it was made by "worms"; some of them thought it grew like flax or cotton.

But a secret like this cannot be kept forever. By and by it leaked out, and in due time it traveled all over the world. There is a story that a certain Chinese princess who was going away to marry a prince in India could not bear to be parted from her silkworms, and so she hid some of their eggs and some mulberry seed in her headgear and took them along with her. Then in India she planted the mulberry seed, and when the trees grew up she hatched out the eggs; and when there were plenty of worms feeding on the trees, she taught the people in India how to make silk. That may not be just the way the secret came to India, but at least it came. It also went over to Japan. For about 300 A.D. some of the Japanese managed to get four Chinese girls to come over to their land and show them how to grow silkworms and make silk. And from that day to this, Japan has been a most important land in giving us our silk.

All through the days of Greece and Rome silk was so costly that no one but an emperor or some other very rich person could wear it. Not until the sixth century after Christ did the Romans learn the secret of the Chinese. At that time two monks who had been to China told the emperor Justinian how they had seen the Chinese making silk, and the emperor sent them back to China to bring some eggs of the silkworm, together with anything else that was needed to start the silk industry in the West. It was a dangerous business for the monks, for there would be no chance to get out of China alive if the people there knew what they were carrying. But they managed to bring the eggs hidden in their hollow bamboo canes, and those eggs started the silk industry, or "sericulture" (sĕr′ĭ-kŭl′chẽr), in the lands of the Roman empire. It reached Spain in the eighth century, Sicily and Naples in the twelfth, and France in the seventeenth; and ever since, there has been sericulture in various parts of Europe, especially in France, though we still look to the Far East for most of our raw silk.

Photo by Field Museum

This woman of Mongolia, a country north of China, has put on her very best silk dress, which she wears only upon state occasions.

Many attempts have been made to raise silkworms in other parts of Europe and in America, but never with any great success. Very soon after the colonists came over to

Photo by Cornelia Clarke

Here is a nursery of infants six weeks old. Every day each one of them eats up its own weight in mulberry leaves. No wonder they have grown fast! But they will need it all later— to spin into silk. So they saw away at the leaves, and the rustling sound when thousands are feeding is like the falling of rain.

Virginia, King James I sent over some eggs and mulberry trees to them, and did everything he could to start a rich industry in America. The thing had been tried by Cortes in Mexico still earlier, and it has been tried in many places in the New World since. But here, as in many other places, the main trouble is that it does not pay to grow silkworms and handle their cocoons unless there is a great deal of cheap labor, for the business is a long and tedious one. That is why we still look to the Far East for most of our raw silk, though a goodly amount is produced in the warmer parts of Italy, France, Spain, Austria, and a few other countries. In the main we get our raw silk from China and Japan and India, and make it into cloth with the machines of our own lands. A large part of the world's product comes to America – to the mills in New England, New York, and Pennsylvania, and especially at Paterson, New Jersey. In Europe the city of Lyons, in France, has long been the silk capital, but there are also important mills in Great Britain, Germany, Italy, and Spain.

A King's Robe for Everybody

That is about the way in which the finest of all cloth has spread out of China all around the world and grown so common that what was once a garment for kings alone may now be worn by nearly anybody, and used for many other purposes as well. And now we ought to say something about the little worm that gave us the whole industry and still supplies all the silk in the world.

The Worm That Makes Our Silk

In the first place we might say that we could make silk, or something like it, from the stuff spun by many another creature besides this worm– there are dozens of others that make cocoons which we could use if we had to. We could even make silk out of spiders' webs if we wanted to, and if it paid to do so. But the silkworm that came from China does the work so much better for us that we use him in preference to all the others. So for thousands of years we have been taming him and raising him, in millions for our silk.

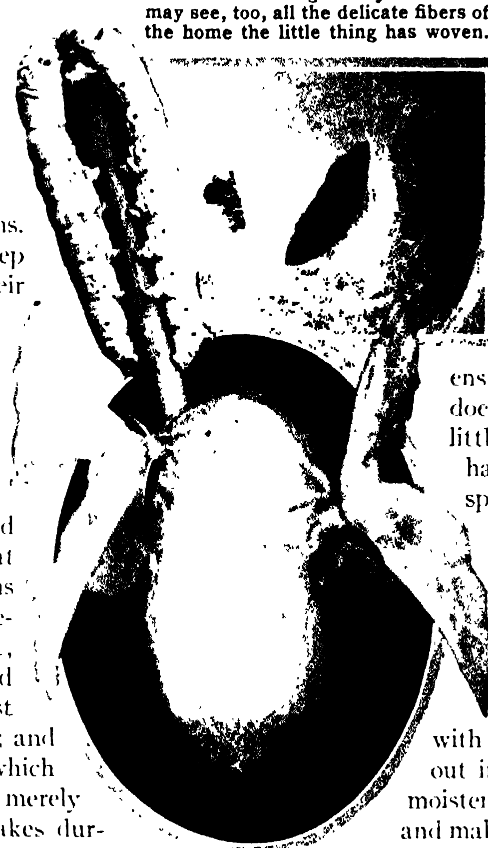
Yes, taming him. Our silkworms, or nearly all of them, are tame creatures that we must breed and feed and tend very carefully if we are to have the best silk they can give us. They are easy enough to tame, for they never care to go far away from their birthplace. They stay right in the houses we build for them, eat enormous quantities of the food we give them, if we take pains enough to serve it just to their taste, and very rapidly grow up to their full size.

Then they spin their fine cocoons all round themselves and go to sleep. If they woke up they would be very different creatures, like all the other insects that spin cocoons. But they never wake up, except for a very few that we keep to lay eggs and so give us another crop of silkworms. For while they are asleep we steal the silk in their cocoons for our ribbons and dresses, and they never know the difference.

Now of course you have guessed that they are not really "worms" at all. You have read about other insects that go to sleep in cocoons and wake up into something quite different, and you have gathered that the silkworm must be an insect. So he is; and the wormlike stage in which he spins his cocoon is merely one of the forms he takes during his changeful life. The following is the course of his life.

His mother is a moth. She is a whitish creature with a body about half an inch long, and her Latin name is *Bombyx mori*. She has wings, of course, but she does not fly much, and seldom travels more than a few feet from the cocoon out of which she has come. She lays from three hundred to five hundred eggs, and then in a few days she dies. In due time the eggs hatch out into little wrigglers like caterpillars. These are enormous eaters; they will soon be eating as much as their own weight every day out of the mulberry leaves which they love. Of course they grow very fast—so fast that four times in their short life they get so plump that they have to shed their skins and grow new ones. In six weeks or more they are full-grown—about three inches long—and are ready to spin their cocoons.

In the square just below is the chrysalis which is shut up inside every silk cocoon. It is the neat capsule the silkworm does itself up in for its nap in the cocoon. Here the silken cradle has been opened in order that we might see its sleeping tenant—and that means that this particular worm will never wake up again. Beside it is the caterpillar skin which it shed on becoming a chrysalis. You may see, too, all the delicate fibers of the home the little thing has woven.



Photos by Cornel

The two silkworms on the twig above have eaten their fill and are looking for a cozy place to spin their cocoons. In the oval above are two female silkworm moths. One of them has just come out of the cocoon, and is drying her soft wings. But they will never be of use to her, for generations of leading a lazy life have made her too weak to fly.

Each of them has two big glands full of a sticky substance which is forced through a little opening in its lower lip. As this comes out into the air it hardens into a fine thread, just as does a spider's thread. The little fellow will spin at least half a mile of it. As he spins it he winds it round and round him, covering himself up in his tight cocoon. Then he goes into his next stage, that of a chrysalis (krĭs'-ȧ-lĭs). In two or three weeks he is through with that, and ready to come out into the world again. He moistens one end of the cocoon and makes his way out as a moth. He will be the father of a new crop of wrigglers.

That is what happens in his wild state. In his tame life, when we are growing him for his silk, we watch over all these processes and take the utmost care to see that they happen just when we want them to, and under the best conditions. And there are very few "pets" that have to be tended more carefully if we are to get the best work from them.

First we gather all the eggs and keep them in a cool, dark, but well-aired place until we are ready for them to hatch. We must have them all hatching at the same time, so that we may feed and treat the young all alike from day to day; it would never do to

have to treat and feed them one by one or in little groups. We shall want them to hatch out in the spring just as the mulberry leaves are putting forth their tender buds, for that will be their food. At the proper moment we put the eggs, which are called "silk seed," into trays in a special room, and gradually raise the temperature to the right degree—about 77° Fahrenheit—at which they will hatch. In other words, we incubate the "silk seed" very much as we incubate hens' eggs.

As soon as the little wrigglers appear, we place a sheet of paper with small holes in it, or of gauze, over their tray, and put some chopped mulberry buds on top of it. The creatures climb through the holes to feed, and in doing so they scrape off any bits of shell that may be clinging to them. Then they start their ravenous course of feeding. In a few days they will be eating whole leaves; and they grow just as fast as the leaves do, so that they can always have the kind of food they need. But we must be very careful in giving it to them. If it gets a little too dry, they will starve before they will touch it. And we must have a great deal of it for them, for soon they will daily be eating as much as they weigh, and toward the end twice as much. They are very finical fellows in many ways. They need plenty of room, because they grow so fast from day to day; they must have the right temperature, enough light but not too much, plenty of fresh air—and not too much noise! At least at the periods when they are changing their skins, when they stop eating for a day or so, they must have quiet—and at those times their owner is not likely to let any visitors into their houses.

If the owner treats them well, they will

Those seedlike eggs which the silkworm moth at the right is laying are no bigger than a pinhead. But inside each one is a hairlike black worm that will grow in only six weeks into the three-inch caterpillar which spins the silk for our dresses.

At the left the silkworms' feast of mulberry leaves is being gathered. The worms from a single ounce of eggs will eat a ton of mulberry leaves.

After six weeks of tireless eating the silkworm works for two or three days spinning its cocoon. As soon as it has finished, the cocoons are gathered, or "harvested," as is shown at the left. Now the little worm will be put to death and the delicate thread all unwound.

At the right the silkworms are being fed on the mulberry leaves they love so well. The tiniest infants have to have the food chopped. But they soon grow large enough to begin on the full-sized leaf. They saw a little semicircle out of the edge of it, and then hold the piece with their forefeet while they eat it down.

Phot by Th Mitsui & Co

nearly all grow up to make silk for him. In a little over six weeks they will be about ten thousand times as big as when they were hatched; and a single ounce of "silk seed" will have turned into about thirty thousand "worms," which will eat about a ton of mulberry leaf and reward the owner with about twelve pounds of raw silk.

A Dainty Nest of Silk

When it is time for the silkworm to spin his cocoon he lets us know about it. He lifts up the front part of his body and waves it about. We must have good places ready for him to place his cocoon. There must be room enough, or two worms will club together in one cocoon, and get their threads so mixed up that we could never unwind them. In his wild state the worm would attach his cocoon to the branch of the tree; so in his house we must have plenty of branches of brushwood or some similar thing for him to use. He does the rest, and in a few days he is all wound up in his silk cradle.

Photo by Field Museum

The spring has come and the tender mulberry leaves are unfolding. Now the grower of silkworms puts the tiny eggs, or "seed," into this incubator, which he keeps at the right temperature to make the eggs hatch. Sometimes he raises the temperature of the whole room and sometimes he simply carries the eggs around in his clothing.

And that, as we said, is his end. We kill him as soon as he has gone to sleep in the cocoon, usually by hot air. And at his death our crop of silk may be said to be "harvested." But we are going to see that we have a great deal more to do before it is ready to go to the mill, and a great deal more still before it comes out in fine cloth. As yet we just have a lot of cocoons on our hands, with dead worms inside them.

Of course we do not kill quite all the worms. We need a few for more eggs. So we carefully preserve a few of them, and let the moths grow up. Then we know what happens. They live for a little while, and leave us the eggs for the next generation.

And yet it is by no means so simple as that. Silkworms have been living in a tame state for thousands of years, and like all other creatures that are no longer leading a natural life, they get into many kinds of trouble. In particular, they develop a good many diseases, and some of these are highly contagious. So all along we need the services of experts, often sent out by the governments, with their microscopes and X-ray machines and other instruments, to watch over the worms and test them for maladies of various kinds, to weed out the ones that may be ill, and to stop the spread of epidemics that would cost us millions of dollars. The great French scientist Pasteur (päs'tûr') won undying fame for conquering a mysterious disease of the silkworms which was threatening to destroy the whole silk industry in France; and many another scientist has followed in his path.

Above all, we need the experts when we come to choosing the worms that will be allowed to grow up into moths and lay the eggs for the next generation. For just as we have bred other animals to give us more and better meat or eggs or milk, so for centuries we have bred silkworms to give us greater quantities and better qualities of silk. And since the breeding is still going on from year to year, we need the best advice we can get to secure the healthiest parents for productive children. So the care of silkworms is a science in itself, and the breeding of them is another.

But we were left with a mass of cocoons on our hands, and we must now see how they are to be made into silk. Most of that story we are going to tell in the pictures

Photo by Hungarian Govt.

Here are women in Hungary sorting the silk cocoons before the thread is unwound. The best cocoons are kept, and the moths allowed to hatch and lay more eggs. The damaged cocoons, too, are thrown aside.

you will find on these pages; we can tell it better in that way. Yet we may say a few words to help the pictures tell their tale.

If you can get hold of the end of the thread that the worm has spun into the cocoon all round itself, you can fairly easily unwind it. But it is not easy to get at the end, as you will see if you try to find it in any sort of cocoon. The threads are all gummed together, and the outside of the cocoon is a mass of fluff. So we first put the cocoons into a vessel of boiling water. As they float on the top, the water softens the gum that holds the threads together; and then a broomlike affair stirs the cocoons around until the coating of fluff comes off and lays bare the true thread.

How Silk Thread Is Made

What becomes of the fluff we shall tell a little later. At this moment we can catch up the thread that is now laid bare. We put our cocoons into another vessel of boiling water and start to pull out the threads. They are very tiny. So we twist a few of them together, usually about six, to make one larger thread, and then we start this thread running through a complicated machine which pulls the threads off the cocoons, as they bob about on the top of the water, twists them and dries them, and finally winds them on a reel It is fast work, and it needs a skillful person to watch it. If a thread breaks, the worker must attach another in its place at once, without stopping the machine; and whenever a cocoon is all unwound, another must be started unwinding immediately, with its thread attached where the first thread stopped. Since the threads are almost too fine to see, it is easy to imagine how skillful the workers have to be to do all this so rapidly.

When the reels are full, the silk is taken off from them in skeins. It is then what we call raw silk. In these skeins it goes to the next process, which is known as "throwing." This is a complicated process, and requires a number of machines; but the result of the whole is that the threads are twisted again, then freed from any knobs or lumps that may lurk in them, and then wound together, several threads at once, into still larger threads. These are made into hanks, which are almost ready for weaving into cloth.

Almost ready, but not quite! There are still a few other things to do before we can

make our cloth. The most important is the cleaning, or the "scouring," of the silk. For as yet it hardly looks like the shiny silk we all know, because it is still full of the gum that the little silkworm put on it to hold it together. So we must scour it by putting it into hot soapy water, then rinse it and run it through one or two chemical processes before it begins to look like the fine glossy silk we see about us. Then it will be ready at last for weaving, and we can dye it to any color we like.

In one sense, we do not have to spin our silk as we spin cotton or wool. The silkworm does that for us, and gives us the thread all spun. We have only to combine its threads into larger ones. And about the weaving we do not have to speak here. In our story of weaving we have told how any sort of thread is woven into cloth; and the weaving of silk thread is about the same as the weaving of any other kind, with only such differences as the particular kind of material requires.

But there is something else that we must say about silk before we go on Do you know that plenty of the silk dresses you see are only about half silk, and that the rest is—of all things—tin? Many a woman would be astonished to know that she is wearing a dress mainly made of tin, but such is often the case. For when we scour the gum out of silk we take away about a quarter of its weight, which is a serious loss to the owner. And since silk will very easily absorb and hold various other things in which it is soaked, the owner often tries to put back the weight he has lost, and even a good deal more, by soaking the silk in various chemical baths which fill the fiber with other substances. Commonly he uses tin, but he may employ various other substances.

From raw cocoons like the ones at the left are unwound the skeins of fine silk fibers which are shown in the oval. Then the fibers are twisted together to make a single thread. If the strands are twisted some sixty or seventy times to the inch before the thread is made, the fabric into which they are woven is the crinkly crepe we know so well.

Photos by Co ld Field Museu

Here the silk fibers are being reeled from the cocoon and wound on this little machine. The cocoons were first dipped in boiling water to kill the little creatures inside, and then were soaked to dissolve the gummy substance with which the fibers are stuck together.

By no means all our silk is treated in this way, and some of it comes to us as the pure product of the silkworm, freed only from its gum. But a great deal of it is weighted, more or less. Of course the weighted silk is cheaper. It looks just about like unweighted silk, and commonly wears about as well, though it cannot stand sunlight so long without fading. But being heavier, it hangs even more gracefully than pure silk, when it is made up in a garment.

Now we have to go a long way back in our story. You remember we said we were going to tell what became of the outer fluff of the cocoons which was taken off before we began unwinding the threads. And along with the story of this fluff we have to tell about what we do with a good deal more silky stuff that the silkworm leaves us besides the pure thread that we have been talking about so far.

The middle of the cocoon is made up of the thread we have been dealing with. Outside there is the fluff we have been men-

tioning; and inside there is still more silky stuff that is glued together in such a mass that we cannot unwind it into thread. Then there are bad cocoons, of one sort or another —cocoons in which the worms may have hatched and made their way out, cutting the threads; cocoons made by sick or feeble worms that do not give us good thread; cocoons in which the worms have been crushed, staining the silk and making it hard or impossible to unwind. All these cocoons, together with the outside fluff and the sticky stuff inside, give us a great deal of silky material that does not come in threads, but in masses of fiber—or about the way our cotton or wool comes to us.

Now all these masses we have to treat in just about the same way we treat wool and cotton—with all due allowance for the particular kind of material we are handling. In one word, after putting the masses of silk through all the processes needed for cleaning and preparing them, we have to spin them into threads just as we spin cotton or wool. Then we weave the threads into cloth just as we weave those that the silkworm gives us all ready-made. Of course they do not make quite such fine silk, for nothing can be so good as the natural thread that the worm makes for us. But second only to that, they give us our best cloth.

In the trade the fluff of the cocoons is known as "waste." But of course it is anything but waste in fact. Nothing that the silkworm makes is wasted. The very worm himself, when his cocoon is all unwound and started through the machines, is used for fertilizer—to grow better mulberry trees, among other things.

In all this we have been talking only about tame silkworms and their product. But of course there are still plenty of wild silkworms in the world. And though most of our silk comes from the tame worms, there is still an industry in the cocoons of the worms that grow wild. Before Pasteur put an end to the disease that was threatening to ruin the silk industry in France, a good many people were looking in the Far East for wild relatives of our tame silkworms that might give us silk if the tame ones disappeared. A rather large number of relatives were found, and some of their silk is finding its way into commerce. But it comes in rather small quantity, and as yet, at least, it is of inferior quality. No real rival has been found for the silkworm that has served us for all these thousands of years. The nearest rival is the tussur worm, which gives us what we call tussur silk. Pongee, rajah, and shantung silks are made of tussur.

There is hardly any need to tell of the importance of silk in the world. It is our finest kind of goods, and we all wear it. We shall go on prizing it in spite of the clever and very useful artificial silks we now make and use so much in the form of nylon and rayon. But there are a few uses for silk that many people do not know about. For not only do we make dresses and ribbons, stockings and neckties and thread and upholstery fabrics from silk, along with many other well known things, but we use it for less familiar purposes. We make bags of it to hold explosives, we cover balloons and dirigibles with it, we use it as "bolting cloth" to sift the flour in our flour mills. We make it into plush and velvet, into parachutes, and even into a fine imitation of sealskin. Suppose the little worm from China could know how important he is to his tamers!

The STORY *of* LINEN

Reading Unit
No. 4

THE OLDEST CLOTH IN THE WORLD

Note: For basic information not found on this page, consult the general Index, Vol. 15.

For statistical and current facts, consult the Richards Year Book Index.

Interesting Facts Explained

The first fabric, 9-46
The finest linen of ancient Egypt, 9-46-47
Thread from plant stems, 9-47-48
Hand-woven linen, 9-48
Belgian and Irish linens, 9-48
Sailcloth, 9-48
Invisible thread, 9-48
How flax is grown, 9-47-49

Things to Think About

How can a grass stem provide us with thread?
Why is very fine thread valuable?
Why is Belgian linen the finest?
Why is linen a better material than cotton?

Picture Hunt

How does flax grow? 9-48
How long does linen last? 9-47

Related Material

What kind of plant cells give linen its properties? 2-8-9
How is paper made from linen? 9-276-80
How is linseed oil used to protect our buildings? 9-312
How does Latvia celebrate the harvest of flax? 6-463
How is cloth woven? 10-338, 342-43
How is thread made? 10-339
How is cotton related to linen? 9-28, 32

Practical Applications

How is linen used in aviation? 9-47
How is linen used in the tropics? 9-47

Leisure-time Activities

PROJECT NO. 1: How to make a braided rug, 14-77.

PROJECT NO. 2: How to do appliqué work, 14-73.

Summary Statement

Linen, the strongest and coolest of clothing fibers, has been used by man since the New Stone Age.

Photo by the National Museu

A hundred centuries ago, when they were new, the wooden huts of the Swiss lake dwellers must have looked somewhat like this. It was here, if we read the record right, that people in Europe first learned the use of linen. So we are to think of this old, unknown race as wearing linen garments, and fishing perhaps from the very doors of their odd homes, with linen nets. We have found these things in their huts.

The OLDEST CLOTH *in the* WORLD

Possibly the First Fabric Man Ever Wove Was Linen; Once Made into the Garments of Emperors and Pharaohs, It Still Gives Our Best Laces and Tablecloths

LONG, long ago, before mankind had even found a way to read and write, there lived a strange people who liked to make their homes over the still waters of a lake. All through Central Europe, but especially in Switzerland, we find, on the oozy bottom of lakes like Geneva and Constance, the little wooden huts of the lake dwellers, who lived at least ten thousand years ago. When those ancient homes were new they stood well above the water on stout piles, and in their little rooms there were some rather neat implements—always made of wood or stone or bone.

In those huts we have found, too, bundles of clean flax all ready to be woven into linen cloth. This is the first time a fabric makes its bow in the long drama of the human race. Clearly, this progressive people of the New Stone Age had learned to make cloth by weaving stout fibers of grass. For it would seem that men must have learned to weave before they learned to spin, since there were always grass and fibers at hand, and it was simple enough to weave them into cloth. Later they learned to spin long threads to weave into cloth for their garments—and then they began to weave their sheep's coats into woolen fabrics.

Now we cannot make out that those early lake dwellers knew how to make their clothes of wool, but we do know that they had coats and skirts and ropes and snares and fishing nets made of linen, and we think that in many places linen must have been the very first cloth that men knew how to make. Of course when spinning was invented, wool came to be the more useful fabric for clothing in the north, but wherever the sun was high and hot, people kept on wearing clean, cool linen. In ancient Egypt it was finer and more beautiful than we weave it even to-day, and in its firm, soft folds the pharaohs were wrapped for burial. Those cobwebby fabrics have lasted, some of them, to this very day. In Bible times, too, "purple and fine linen" was the garb of kings.

But what in ancient Egypt was a necessity to everybody has become a good deal of a luxury in our own day. When men learned how to use cotton they were able to manufacture it so much more cheaply that linen fell behind in the race. So to-day we use it for fine tablecloths and napkins, for the more delicate sorts of towels and handkerchiefs, for sheets and pillow cases if we are rich, for certain kinds of fine clothing, and -because it is so strong--for weaving delicate laces and for covering the wings of airplanes. We should like to use more of it if it were not so expensive, for it has a beautiful shining surface that is slow to pick up dirt, it is much cooler than any other fabric, it takes up moisture more quickly, is more easily washed, and is very durable—for though flax, the material from which linen is made, is only a very little heavier than cotton, it is twice as strong. Cotton does have one great advantage, however; it takes a better dye.

The ball of linen thread at the left, the linen sheet below, and the linen-wrapped mummy in the center were all found in tombs in the Valley of the Kings in Egypt. They are all about thirty-four centuries old. On the sheet, as you see, is an inscription. It means something like this: "The good God, Lord of two lands, Nebkheperure, beloved of Min; linen of the sixth year"—of the reign of a certain king. There is something almost uncanny about frail cloth that can speak to us across all those centuries.

The Plant That Gives Us Linen

It is quite a marvel to think that the stems of the little plants that wave their fairylike blue bells in the wind can be made into the soft, transparent handkerchiefs that cost so much for only a few square inches, or into the exquisite figured damask that covers our dining tables. A single stem of these plants may be anywhere from twenty to forty inches tall, and since it does not branch except at the very top, the fibers that make up the soft, silky lining of the bark are already very long, even before they are spun—much longer, stronger, and thicker than cotton fibers are before spinning.

Flax is useful in giving us linseed, which serves us in a number of ways, but when we are going to make linen we cannot give the seed time to ripen. Instead, we pull the plants up by the roots as soon as the lower part of the stem begins to turn yellow. The stalks are tied evenly into bundles and set up on end to dry. An iron comb, called a rippler, will comb out the seeds.

As soon as the bundles are dry and cleaned of seed, it is time for the flax to be rotted—or "retted," to use the grower's term. In Russia, where, before World War I, more flax was grown than in all the rest of Europe together, the dried flax is spread out for a long time on the grass till the pithy core of the stem rots and comes loose from the fibers around it. In most other places the retting is done by soaking the bundles in water, either in ponds or streams, for some ten days or two weeks. There is also a way

of retting the flax in warm water inside a heated building. This takes only two days, or a little more, but it is expensive and has never taken the place of the other kinds of retting. No matter how the retting is done, the rotting pith gives off an unpleasant gas, which rises to the top of the water in bubbles.

It is a delicate matter to decide when the flax has been retted just enough to loosen the pith without rotting the precious fiber. But when just the right stage is reached, the fiber must come out of the water. It is thoroughly dried and then passed through a machine that crumbles and loosens the woody pith. This is called "breaking." Sometimes, even to-day, this is done by hand, for the linen industry is still very primitive in many places. Throughout Central and Northern Europe, which is the region where flax for linen is chiefly grown, the thrifty peasants grow their own flax, and spin and weave it themselves into cloth for their own use—and they do it all by hand.

A. Harvesting flax in Oregon. But most American flax is grown for its seed rather than for its fiber.

B. A bundle of flax being harvested in New Zealand. Notice how tall the stalks are; they will yield long, strong fibers.

C. A corner of a flax field when the crop has been tied in shocks to dry. The seeds will next have to be combed out and the pulpy part of the stem rotted away to free the fiber.

...s by U. S. Dept. of Agri. & New Zealand Govt.

Making Thread from Flax

After the retted flax is broken, the fibers are scraped, by hand or machine, till they are free of the bark or pith that still sticks to them after the "breaking." This scraping, or "scutching," leaves the fibers a silvery gray in color—unless they have been retted in dew; then they are brown. At last they are ready to be tied into bundles and sent off to the mill, there to be carefully combed, or "hackled," until they are fine and soft.

But even yet they are not ready for spinning. They must still be graded as to quality, and drawn out by machine into an even ribbon, or "sliver," that shall contain the same amount of smooth fiber throughout its whole length. Over and over the fiber is smoothed and drawn out in this way, until at last it is ready to go to the "roving" frame, where it is twisted a little and wound on bobbins. In this form the fibers are called "rovings," and are ready to be spun.

Elsewhere in these books we have told of the wonderful machines that spin and weave all sorts of fibers into cloth. Most of our finest linen is manufactured in Ireland. Yet in some ways Belgium would seem to carry off the palm, for the finest flax in the world comes from Courtrai, and the spinners who spin it by hand are said to be able to turn out a thread so fine that it cannot be seen by the naked eye. This marvelous spider's web is used in making laces. A single pound of it has sold, it is said, for \$1,200. At Cambray a filament was spun so fine that 272 miles of it were needed to make up a pound.

Most of the finest weaving, too, is still done by hand, on looms which may often be found in the little cottages of Ireland and Norway and Sweden. Heavy linen fabrics, like sailcloth and canvas, come to us mostly from Scotland; but it is Northern Ireland that sends us most of the finer grades. Belfast is one of the greatest linen centers in the world. Belgium, too, sends us damasks and handkerchiefs, and France gives us fine linen yard goods. England and Scotland make sheets and towels; we make toweling, twine, and thread.

Reading Unit No. 5

A FEW SURPRISES IN BUTTONS

Note. For basic information not found on this page, consult the general Index, Vol. 15.

For statistical and current facts, consult the Richards Year Book Index.

Interesting Facts Explained

The first use for buttons, 9-50
The oldest buttons, 9-51
Substances used in making buttons, 9-51
Where buttons are made, 9-51-52
Buttons as a sign of rank, 9-52
People who are not permitted to use buttons, 9-52
Buttons from the sea and rivers, 9-51
Glass button, 9-52

Things to Think About

In how many ways are buttons used to-day?
How was clothing fastened before buttons came into use?
How do boys and girls use buttons for other purposes than for clothing?
How are buttons used by people employed in government and the public utilities?

Picture Hunt

How are clams collected from bodies of water? 9-52
How is mother-of-pearl changed into buttons? 9-51

Related Material

What are some prehistoric mollusks? 3-9, 15, 18, 24, 64
How do clams develop from the egg? 3-148, 158
How are pearls obtained from shellfish? 3-162, 262
Which shellfish live in fresh water? 3-254-62
How are button pearls made? 3-164
What is mother-of-pearl? 3-262
How is casein, a milk product, used to make buttons? 9-347
How are buttons obtained from the horse? 4-506-7, 9-51

Practical Applications

How are buttons used as ornaments? 9-52
How are buttons used in our clothing? 9-50-52

Leisure-time Activities

PROJECT NO. 1: Make buttons from as many different materials as you can.

PROJECT NO. 2: Collect and mount buttons made from different materials.

Summary Statement

Buttons are very small but useful additions to clothing; and their history is both ancient and interesting.

The buttons on the back of this gentleman's coat would be really useful if he would button his coat tails up out of his way with them. When coat tails were a bit longer than his, men actually did button them up. And some say that these puzzling back buttons were originally meant to hold the belt that held a gentleman's sword.

A FEW SURPRISES *in* BUTTONS

Even though You Think You Know All about Them, You Can Probably Find Out Something New in This Story

NOW what on earth is there to say about buttons? Surely a button is just a button, and that is all there is to it.

Well, why do you wear two or three buttons on your sleeve, where they never do any earthly good? Why does a man with a long-tail coat have two buttons right in the middle of his back, where he can never use them? And why do men and women wear so many other buttons in places where they are never needed?

Not so very long ago a man had to do nearly all his traveling on horseback. He wore a long coat with flying tails, and the coat tails would get hairy and greasy from flapping against the horse's sides. So he put two buttons on the back of the coat and buttoned up his coat tails behind him when he started off on his horse. He also wanted his arms as free as possible, especially when he went hunting. So he cut a slit in the end of his sleeve and sewed some buttons along it, then he could double the sleeve back and button it up on his arm.

Now man is a funny creature. Once he gets used to a thing, he simply will not give it up. Even if he has no earthly use for it any longer, he will keep it going somehow or other. He never dreams of turning up his coat sleeves now, and he hardly ever wears a coat with long tails. But he still has to have his buttons on the sleeve, and he will not buy a coat without them; while if he does wear a long-tail coat, he must have his two buttons on the back of it. And so with many of his other buttons. The buttons have a history, after all, and here is a little part of it.

When men first began to wear clothes, they had to find some way to fasten them on. Doubtless the first thing was a thorn taken from some sort of bush and used as a pin. Then a man learned how to make his own thorns, by trimming little sticks to a sharp

point. These would be better, because he could always have them ready, and in just the size he wanted. Later he might punch holes in the skins or cloth he wore, and run laces through them. That is as far as the Greeks and Romans ever got, and to this very day there are people in the world who have never got so far as that—for there are still certain savages who use nothing but thorns and sharp little sticks to fasten up their clothes. And all of us still use all these methods, in our pins and laces, though we now employ buttons more than anything else.

If the shell fishermen below are very lucky, one of them may some day find a pearl. But it is from the mussel shells themselves that buttons are made. These are boiled to take out the meat, soaked for a week, and then cut into round disks, as at left. Of course these disks, or "blanks," are going to be the buttons—after they have been ground and polished and pierced, as the picture shows.

Photo by American Museum of Natural History

Yet we came to buttons pretty late. It was only a little before the time of the discovery of America that we began to use them, and even then they were first worn mainly or entirely for ornament and not for use. But they slowly came to be the main things for fastening our clothes around us, until to-day we have great machines for turning them out by the million, and other machines for cutting and sewing the buttonholes into which they fit.

Buttons are made of all sorts of things -- gold, silver, brass, iron. bronze. copper, glass, porcelain, wood, paper, cloth, horn, bone, hoof, pearl, ivory, sea shells, and still other substances. Many are made from plastics, or composite substances, and in these we even use blood and casein (kā'sē-ĭn)—which is the cheesy substance in milk. In the United States a great many buttons are made out of "vegetable ivory." This is nothing but the nut or seed of the tagua palm, found in the northern part of South America. We bring in many thousands of tons of these valuable nuts every year to be made into the pretty buttons that can be tinted and colored to match the kind of cloth they are to go with.

We also make millions of buttons out of shells from the sea or from the fresh-water mussels that are usually called clams. The great place for making these is on the Mississippi River in Iowa. A single company there can turn out about five hundred millions of the buttons every year.

Of course buttons are made in many other places. At Birmingham in England people

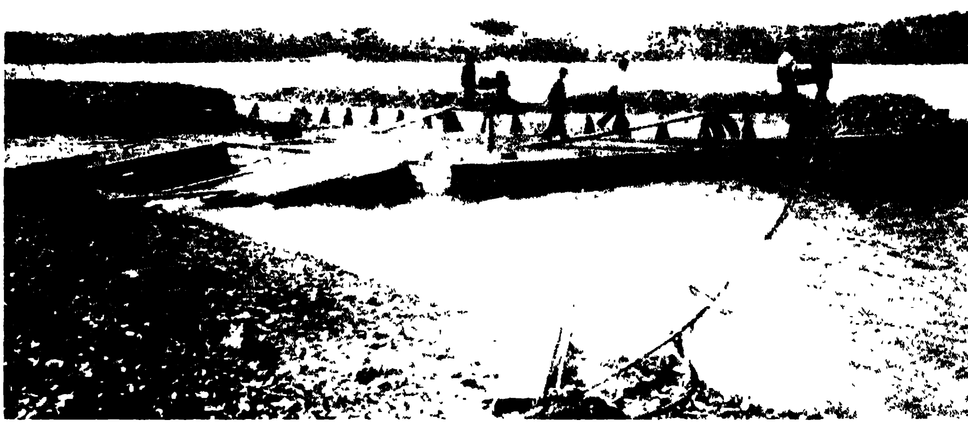


Photo by American Museum of Natural History

These great scows have been moored to the bank of the Mississippi, in Iowa, and loaded with the fresh-water clams that grow there. Now those heaps of shells will go to the factory to be turned into buttons.

began to make brass buttons some two hundred and fifty years ago, and to this day Birmingham remains the center of the trade for Britain. Czechoslovakia makes many of the world's glass buttons, and the secret of their manufacture is rigidly kept.

From the very start buttons have been worn for many other purposes besides hooking up our clothes. They have been used for many a kind of ornament, and for marking many a sort of distinction, social or official. Long ago the rich people used to wear buttons of gold or silver or precious stone, and sometimes they even made laws forbidding the plain people to wear any buttons at all—for a man's rank was known by the buttons he could wear. He would also decorate his books and knives and swords with handsome buttons.

And of course we still use buttons a great deal to show a man's rank. A policeman wears a certain kind of button, and the worst disgrace that he can meet is to have his buttons cut off. Guards and guides in public places, railway men, and many other officials have buttons to show their rank in the service and their duties to the public. All men in the army and the navy wear buttons that will tell at once what rank they hold. Millions of boys and girls have special buttons to show their class in school or college, or their favorite club. Millions of men wear the button of their fraternal order so that they may know one another anywhere they meet. When you see two perfect strangers on a train fall into friendly talk, there is a good chance that it all started with a button, followed by the hand-grip of their particular order. So buttons still do a good deal of work besides keeping our clothes on.

There are a few people in the world who will not have anything at all to do with buttons. They have religious reasons for it. For instance, the Dukhobors (dōō-kŏ-bôr′) in Canada will never wear a button. It is part of their religion never to kill an animal, and since so many buttons are made out of the horns and bones of animals, they do all their fastening with pins and laces, or with hooks and eyes. Buttons are little things, but they are very important.

The STORY *of* SHOES

Reading Unit
No. 6

WHAT WE WEAR ON OUR FEET

Note: For basic information not found on this page, consult the general Index, Vol. 15.

For statistical and current facts, consult the Richards Year Book Index.

Interesting Facts Explained

Shoes that deform feet, 9–56
Sandals, 9–56-57,
Moccasins, 9–56-57
Ridiculous shoes in history, 9–57-58
High heels, 9–58
Handmade shoes, 9–58, 59, 61
Machine-made shoes, 9–61, 64
Methods of sewing shoes, 9–62

Things to Think About

Why can people walk faster in shoes than in bare feet?
How did the Civil War speed the production of machine-made shoes?
How long did the shoemaking tools of the Egyptians remain in use?
What is the origin of the story of the Seven League Boots?

Picture Hunt

What kinds of shoes have people worn in the past? 9–56-57, 60
How are shoes made to-day? 9–62

Related Material

What kind of shoes should you wear in camp and on a hike? 14–551, 556
How do shoes affect our health? 2–419
What kind of shoes do the Japanese wear? 5–364
How are shoe sizes determined? 10–374
What determines the price of shoes? 7–532-38
How is leather tanned? 9–66-68, 70-71
Which animals give us our leather? 9–66, 69, 72
What kinds of leather do we use in shoes? 9–70

Practical Applications

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How did the Indians make moccasins? 9–60

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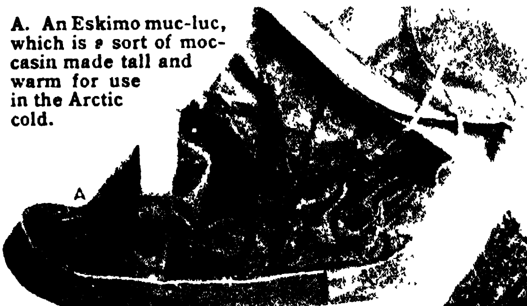
PROJECT NO. 2: Make a pair of woven grass sandals, 9–58, 60.

Summary Statement

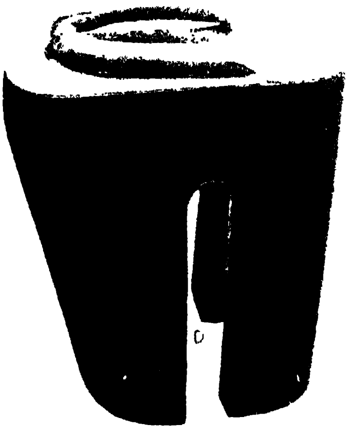
In the past, shoes were expensive because they were made by hand; but with the invention of the sewing and shoe-making machines, good shoes can be produced for everyone at low cost.

A. An Eskimo muc-luc, which is a sort of moccasin made tall and warm for use in the Arctic cold.

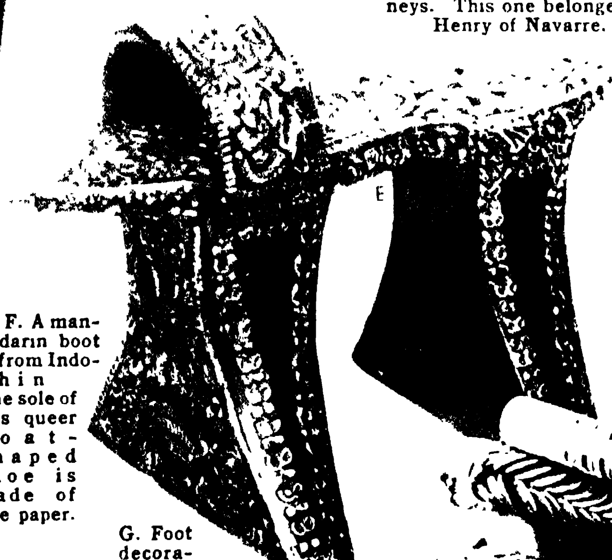


B. A sumptuous slipper with high red heel, once worn by some noble lady of Venice.

C. A jousting boot as worn in sixteenth century tourneys. This one belonged to Henry of Navarre.



D. A Japanese clog, about eight inches high. It is meant to add height and dignity to the wearer on ceremonial occasions.



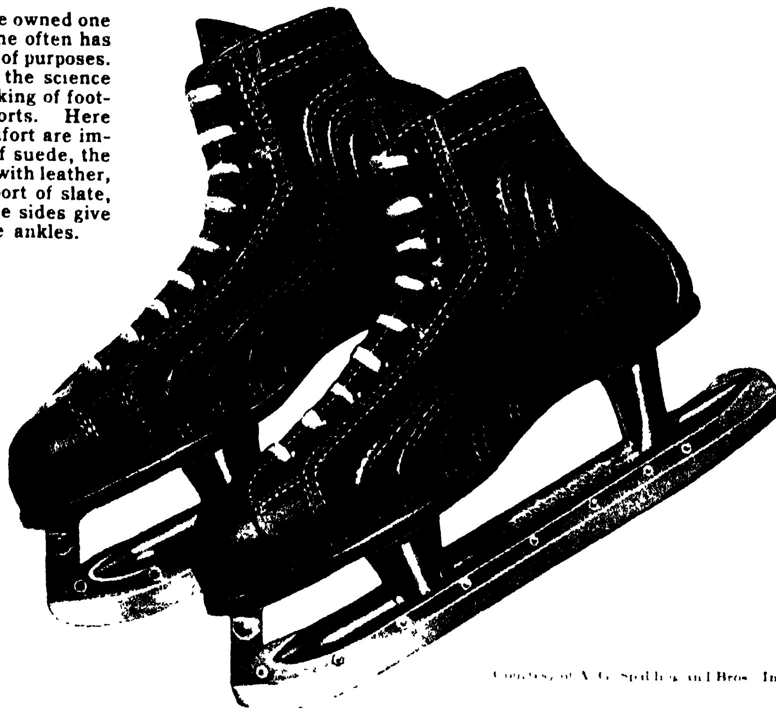
E. An old Turkish bath sandal. Clearly these were not comfortable bedroom slippers, such as one might expect. On the contrary, for centuries they had an important part in certain Mohammedan ceremonies.

F. A mandarin boot from Indo-Chin The sole of this queer boat-shaped shoe is made of rice paper.

G. Foot decoration from Ceylon. This of course is not a shoe at all, for you cannot have a shoe without a sole.

Photos by U. S. Machinery Co. and Grau

A man used to be lucky if he owned one pair of shoes. Nowadays he often has several pairs for a variety of purposes. These hockey shoes show the science and skill that go to the making of footwear for the various sports. Here strength, warmth, and comfort are important. So the lining is of suede, the toe is a steel plate covered with leather, the arch has a strong support of slate, and the curved welts at the sides give extra strength over the ankles.



Courtesy of A. G. Spalding and Bros. Inc.

WHAT WE WEAR *on* OUR FEET

If You Think That Shoes Are the Plainest Part of Our Attire, You Ought to Read about Some of the Wild Fashions They Have Seen

NOBODY really knows whether the men of old first started to wear clothes in order to keep warmer or in order to look prettier. In the case of shoes, however, we may be more certain. They must first have been put on for use and comfort. It is true that we can be very comfortable, in the right places and the right weather, with our feet bare, and we might all be a little healthier if we went barefoot a little more. But very long ago our fathers found out that their feet were better off, especially in the wild woods and in rough country, with some sort of shoe. The feet were far less tired and bruised after a long trip through brush and briar, or over stony ground; they were not burned on the hot sands of the Tropics or frozen in the snow and ice of the north.

Long ago people began to wear shoes, or at least sandals, nearly everywhere. In due time the shoes grew stronger and more comfortable, and thus more and more important. A man could chase a deer or other prey faster and farther if he was shod. An army in shoes could overtake or leave behind an army that was barefoot. And people could get around to nearly all the business of life far more safely and rapidly if their feet were covered. Indeed we may

say that civilization has gone forward at about the same pace as shoes. No one knows this better than the general of a great army. Every government has made long studies to see just what kinds of shoes were best for its soldiers. There were few things that the great Napoleon thought more important than the footwear of his men; and it is no accident that the two generals who finally conquered Napoleon—Wellington and Blücher—both have shoes named after them.

If shoes are so old and so important in our history, it is no wonder that they play a part in some of our most ancient customs and stories—in the folklore of many peoples. In the Book of Exodus we read that the Lord commanded Moses to "Put off thy shoes from off thy feet, for the place whereon thou standest is holy ground"; and on account of the same feeling the Mohammedans and Buddhists leave their shoes at the doors of their churches to-day, just as we take off our hats. Because they could travel so much faster in their shoes, our fathers made up a great many stories, in various lands and languages, like the one of the Seven League Boots; and for more or less similar reasons they made up those of Puss in Boots and of Cinderella. So shoes have played a part in the literature of the world.

Photos by Field Museum and Presse-Photo Berlin

This Japanese cobbler is making queer, flat Japanese shoes out of the wood of the paulownia tree. They will be worn with the flowing kimona, and will look like the ones on the feet of the lovely lady at the right.

How We Imprison Our Feet

It is quite true that while the shoe has protected our feet, it has also stunted their growth and use. We hardly use our feet for anything but walking. If we had not cased them up in boots for so long, we might have learned to do many other things skillfully with them. We can form some idea of what they may be used for by watching a man who has lost his hands handle a knife and fork or button up his clothes with his toes. Of course we do not need our toes for that, but all the same what we have gained in walking we may have lost in some other ways. At least, our feet remain the least developed part of our bodies; and in some cases the absurd fashions in shoes have ruined the feet of their wearers as in old China, where a fashionable woman used to have her feet so bound up from babyhood that they seldom grew more than five inches long, and sometimes not more than three. The very thing that was meant to help her walk kept her from walking at all. There is a law against that in China now though it has come only recently. But there is no law in our own land to keep people from wearing shoes that pinch in order to make their feet look small. As we go on we are going to find that fairly often there have had to be laws about shoes, because people were so often foolish about them. There is something in us that makes us rather proud about the looks of our feet and often rather silly about the comfort and use of them.

The first shoes may have been simple sandals, or soles with some sort of string to tie them to the ankles. About one third of the people in the world still wear only sandals on their feet, and in hot countries these are very sensible. In colder countries especially, the very early footwear was often simply a skin, with or without the fur, wrapped around the foot and drawn up around the leg with a puckering string. That may well have been the beginning of the moccasin, as worn by the American

"No one but the wearer knoweth where the shoe pinches," is the legend under this old English painting. How desperately our gentleman is trying to make the cobbler understand that the shoe *does* hurt, right *there!* The fit of our shoes is so important to us that we have many sayings about the matter. When we discover what it is that someone dislikes about a thing, we say, "So that's where the shoe pinches!" When someone thinks that we are blaming him without mentioning his name, we say, "If the shoe doesn't fit, don't put it on."

Indians; and there are still some traces of the old puckering string, not only in the moccasins of the Indians, but in those of the Eskimos and the Laplanders.

The Queer History of Our Shoes

Of course the best stuff for most shoes is leather, but while this came very early it may not have been the very first material, and it is by no means the only thing that shoes have been made of. The early Egyptians had very few leather sandals, but mostly made them out of plaited papyrus or some other vegetable fiber. The Hebrews used linen and wool. The Greeks gave the sandal the touch of art which they gave to nearly everything, and made it fit more firmly to the foot. In our own day a great many wooden sandals and heavy wooden shoes are worn in various parts of the world—not only in many sections of Europe, especially in Holland and Brittany, but also in Japan and many other places. The Japanese are still mainly a sandal-wearing people. It is hard to see how a man can get along in a stiff, heavy wooden shoe until we watch him go—but then he seems to go pretty well. Yet he *does* make a lot of noise—how different from the Indian in his moccasins stealing up on his prey!

As we come down through the centuries from early times we meet some very queer fashions in shoes—some crazes as absurd and almost as harmful as the binding of the feet in China. Toward the end of the Middle Ages there was a fashion, at least among the rich, for very long points on shoes. Sometimes the point of the shoe was as much as two feet long, for this was supposed to be very beautiful; and since it would not lie well on the ground in front of the foot, it had to be turned up and fastened to the knee—perhaps with gold or silver chains. Sometimes it was set with precious stones. This fashion seems to have started in France, where it lasted for nearly a hundred years, but it went all over Europe. It grew so bad that people could not walk in their shoes, and both the church and the government had to pass laws to stop it.

Every so often, for some reason in foolish human nature, we get to wearing shoes that

defeat their own end—which is simply walking. Just after the law stopped the making of shoes with absurdly long toes, the fashion set in for having them absurdly broad. Then the soles became so wide for well-dressed people that two men could hardly pass each other on a narrow sidewalk—even if they could walk at all. And this came to be about as much of a public nuisance as the long tips. So again the law had to step in. In England it ordered that no shoe should be more than five and a half inches broad or have a tip more than two inches long.

Above is a very old shoe indeed—an Egyptian sandal of plaited papyrus. To the right is a Roman sandal of leather, with the foot pictured in it so that we may see how the Romans' toes were always—quite properly—coming through their shoes.

Photos by U. S. Shoe Machinery Co. and Metropolitan Museum of Art

Where High Heels Came From

That was in the time of Queen Elizabeth, and we think we are all done with such foolishness. But many a girl and grown woman to-day is wearing slippers with high heels—of a kind that started back in Venice before the time of Queen Elizabeth—which are far from good for her feet and which make it very hard for her to walk far and very easy for her to turn her ankle. We are still finding it hard to let our shoes do the one thing they were meant for.

Of course there is nothing against pretty shoes, and everything in their favor. We have learned a great deal about making shoes pretty since the days when our ancestors first tied a piece of skin to their feet. But we have also had some very queer notions about what was pretty in footwear, and we still have a few. Of course the prettiest thing in shoes, as in anything else, is the beauty that goes with their natural shape and not the deformity that tries to make them look like something else.

How a Shoe Is Made

So much for the history of shoes. Now we may turn to a very interesting question: how is a shoe made? Certainly it is a fine piece of work, as you will see if you just imagine that you had a piece of cowhide and needed to make a pair of shoes out of it. First we ought to say how a shoe *was* made—in the days of old and down to the time of our modern machines. In those days one man did the whole thing, and one pair of shoes was a pretty good day's work; but there have been few artisans more skillful than the old shoemaker. A hundred years ago he was working with just about the same tools that his ancestors had in Egypt over three thousand years ago, though he had learned to turn out such strong and well-made shoes that it is doubtful whether we shall ever see their like again. About all he had to work with were a few lasts—or iron forms for the shoes he was making—a hammer, lapstone, knife, rasp, pincers, wooden pegs, stitching and pegging awls, and—leather.

He would cut out the whole shoe, the sole and heels and all the parts of the uppers, and make them fit the foot of his customer better than many of our shoes now do. The uppers he would stitch together by hand, and the soles he would fasten on with wooden

Photo by U S Shoe Machinery Co

Here is a shoemaker of the sixties in a corner of his little shop. Does he not look like a wise and philosophical old man? Indeed, as he sat alone day after day bent over his cobbling, the old-fashioned shoemaker had plenty of time to meditate, and he often became the village philosopher. There arose a tradition that he, above all others, had his opinion about everything. So when other people did not agree with him, they let it be known that they thought him interfering. "Let the cobbler stick to his last," they said.

pegs which he sometimes carved with his own knife out of dry maple. When the pegging was done he would smooth the sole and take out the ends of the pegs inside the shoe with his rasp. It sounds easy enough, but how would you like to try it, or to wear a shoe that you had made in this way? We have many "shoemakers" left to-day, but they are nearly all shoe repairers; very few of them could make a shoe fit to wear in the way we have been describing.

America's First Shoemaker

Such an artisan was old Thomas Beard, the first shoemaker in America, who came to Salem, Massachusetts, in 1629, nine years after the Pilgrims landed. The colonists were so glad to have him come over with his supply of leather that they agreed to give him fifty acres of land and various special privileges. He and the men who came after him trained up whole generations of American shoemakers. For over two centuries they made all the shoes we had, in the way we have described. Sometimes, especially when they had just finished learning their trade, they traveled about the country making shoes in one little community after another—a custom known as "whipping the cat." Sometimes they settled down in a single place.

The Shoe Capital of America

As time went on a great many of them settled in Lynn, Massachusetts, which became and long remained the shoe capital of the country. As far back as 1812, more than two hundred thousand pairs of shoes were made there in one year all, of course, by hand. Now a great many more are made there by machinery, though of late years Lynn has not kept ahead as before, and places like St Louis and Binghamton, New York, now share her honors.

At the same time when Lynn was becoming so important, little ten-foot shops were

Photo by American Museum of Natural History

Here are some of the shoes worn by the American Indians. All the beautiful beaded moccasins across the top (A, B, C, D, E) were made by the Sioux, as was also the one at K below. F is a sandal made out of the blades of the yucca plant in New Mexico; clearly it is meant for use only in a warm, dry land. G and H, as well as J below, are styles of moccasins made around Hudson Bay and copies by the Blackfoot Indians. The mysterious bundle of fiber at I is a prehistoric snowshoe dug from an Aztec ruin. The other snowshoes, at L, were made by Iroquois Indians. They look much like those some of us like to wear.

scattered all over the country for making shoes. It was in these little shops that the next great step was taken in the growth of the shoe industry. For in them began that "division of labor" which, in shoes as in all other modern industry, is so important. Up to now one man had made a whole shoe; but now it occurred to someone that all would do better and faster work if each did just one part of the process. One might do the cutting, another the stitching, while a third might make the soles and so on. Each man would be more expert and each one could work faster.

In Quebec, where winters are long and snows are deep, these makers of snowshoes will find good market for their wares.

Then came machinery, and a great revolution in shoemaking. In fact, the shoe industry is probably the only basic one in which the revolution took place wholly in America. The first great change came with the rolling machine, in 1845, which saved hours of time by pressing together at a single operation the leather that had formerly been slowly beaten out with a hammer on the lapstone. The next year Elias Howe invented the sewing machine, and twelve years later Lyman Blake made a machine for sewing leather. This was the main thing that made over the whole industry.

Photo by Canadian National Ry

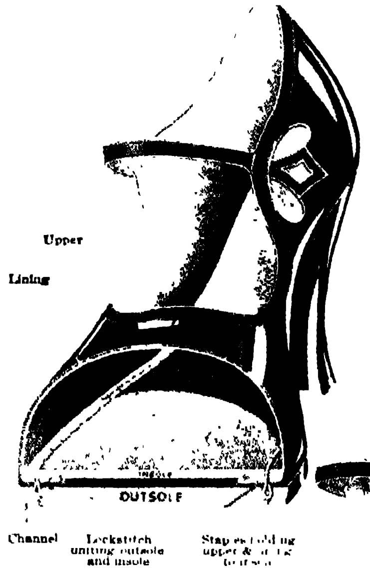
These merry Dutch girls clatter about the streets and fields in their wooden shoes, but may leave them on the doorstep when they go indoors.

At first the machine would sew only the light leather of the uppers, but that was a great saving, and before very long there were machines to sew the soles as well. As time went on these machines were greatly improved into the marvels that we have now. Blake sold his invention to Gordon McKay, and the McKay machine came into use in 1861, just at the outbreak of the Civil War, when there was a large demand for shoes for the soldiers. Then came metal nails, though they did not wholly displace the older wooden pegs. About 1876 came a machine for fastening on the soles with a continuous wire; but this has now gone out of use in this country, and all the soles are now sewed to the uppers of our shoes.

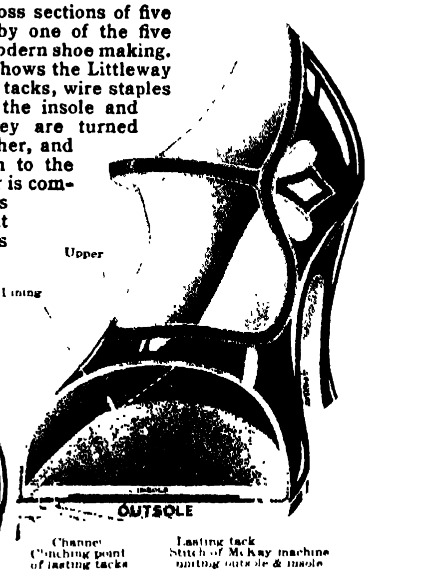
There are no machines much more wonderful than the ones that now do this work. Some of them are as finely adjusted and as intricate as the best watch, and work with the greatest precision; and nobody ought to miss the chance of seeing them at work if he has it.

There are, in all, five ways by which shoes are commonly made in our day. The shoes they turn out look very much alike on the outside, but the methods are really very different, and on the inside the shoes are different too. The five kinds of shoes turned out are called the McKay Sewed, the Goodyear Turned, the Goodyear Welt, the Littleway, and the Stitchdown. There is hardly room to describe them all, but we may tell about one of them. Let us take the Goodyear Welt. It is the most complicated way, and has certain obvious advantages over the others. It was invented, incidentally, by Charles Goodyear, son of the Charles Goodyear who found out the way to vulcanize rubber and so gave us most of the rubber in the modern world.

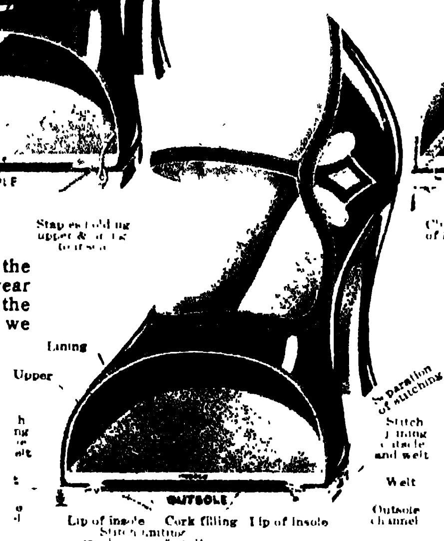
In all there are often as many as 210 different operations in making a Goodyear Welt shoe. They are done by many different persons, and the man who is expert at any one of them may have very little notion



On this page are cross sections of five shoes, each made by one of the five chief processes of modern shoe making. The one at the left shows the Littleway process. Instead of tacks, wire staples are used to fasten the insole and upper together; they are turned over inside the leather, and never come through to the surface. The leather is compressed while it is being sewed, so that the stitching sinks into it.

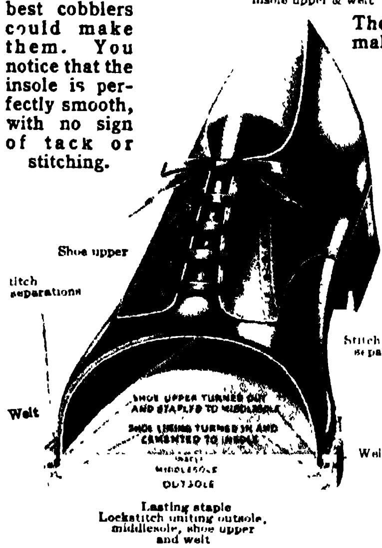


In the center of the page is a Goodyear Welt shoe, about the making of which we have told in this story. Welt shoes are considered the finest of all, and have been so considered ever since the Middle Ages, when only the best cobblers could make them. You notice that the insole is perfectly smooth, with no sign of tack or stitching.



The McKay Sewed shoe, above, was the shoe that turned the cobbler's world upside down because it was the first made by machines. In this shoe the upper and insole are fastened together with tacks. Below is a turned shoe, which gets its name from the fact that it really is made inside out and then turned. It has only one sole, and so is very flexible.

The Stitchdown process, left, makes excellent heavy shoes. It requires a third sole, the middlesole, the use of which is shown in the picture. But its chief feature is that the upper is turned *out* instead of in, and stitched down to the outsole—hence the name.



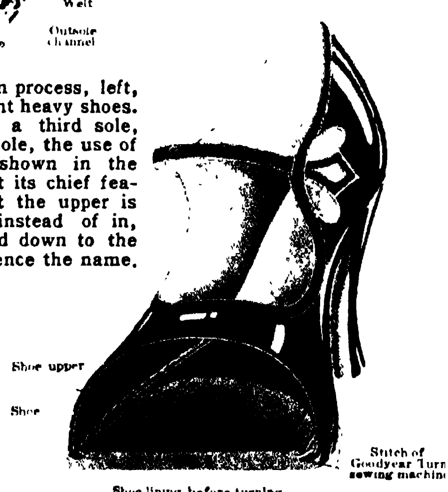
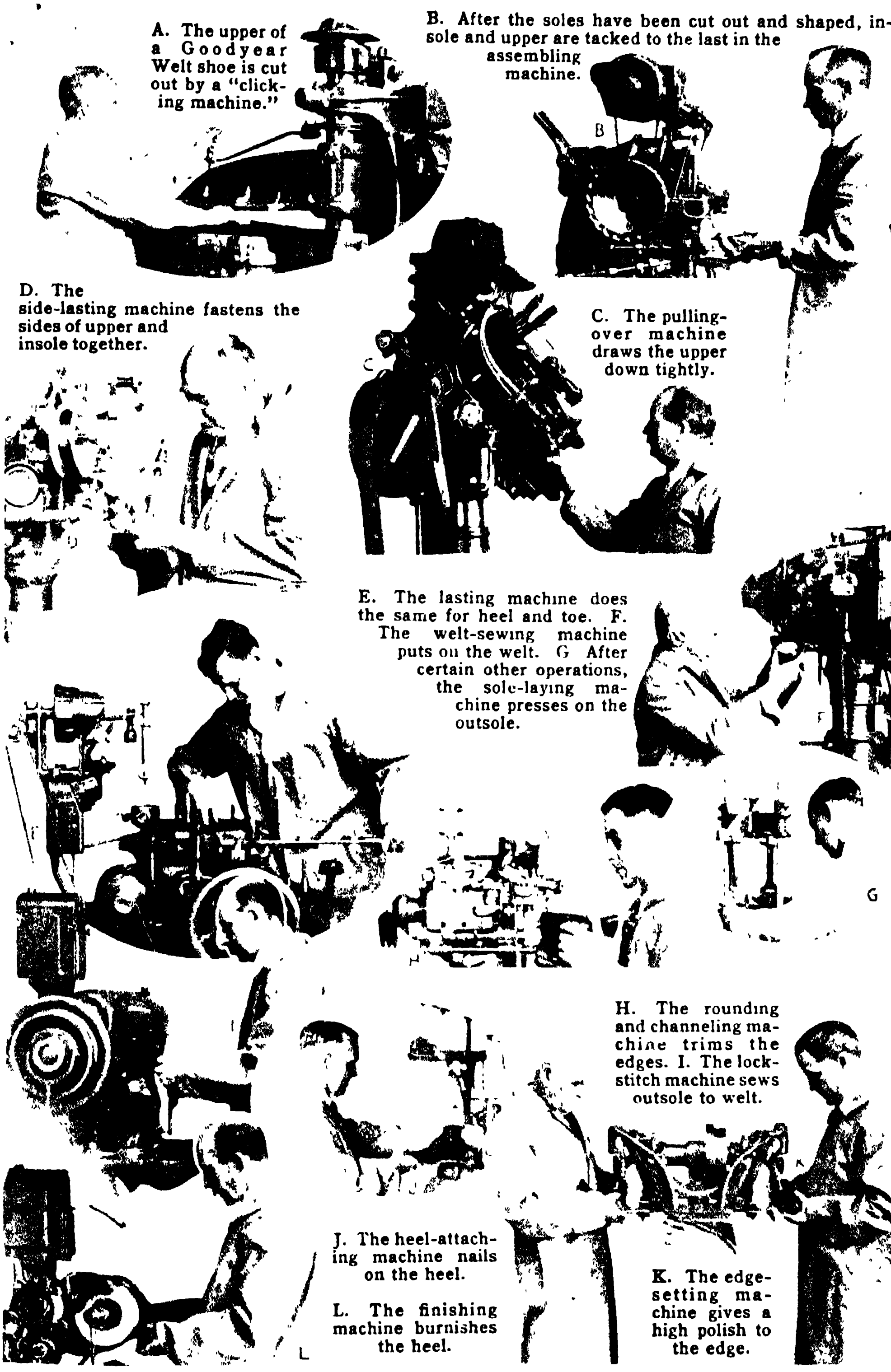


Photo by U S. Shoe Machinery Co.



A. The upper of a Goodyear Welt shoe is cut out by a "clicking machine."

B. After the soles have been cut out and shaped, insole and upper are tacked to the last in the assembling machine.

C. The pulling-over machine draws the upper down tightly.

D. The side-lasting machine fastens the sides of upper and insole together.

E. The lasting machine does the same for heel and toe. F. The welt-sewing machine puts on the welt. G After certain other operations, the sole-laying machine presses on the outsole.

H. The rounding and channeling machine trims the edges. I. The lockstitch machine sews outsole to welt.

J. The heel-attaching machine nails on the heel.

L. The finishing machine burnishes the heel.

K. The edge-setting machine gives a high polish to the edge.

Photo by U. S. Shoe Machinery Co

how most of the rest of them are done. That is what the "division of labor" has come to.

The upper of the shoe, with its many pieces in odd shapes and sizes, is all cut out by what is known as a clicking machine. The sole is cut out by a sole-cutting machine and shaped by a rounding machine. Then it goes through a splitting machine, which gives all the soles of a given kind of shoe the same thickness. All this applies to the in-soles and the outsoles alike. Then the assembling machine tacks the uppers to the last at the heel, and the pulling-over machine draws them down tightly over the front of the last. The side-lasting machine stretches the sides of the uppers, with the lining, tightly into place. Each pull fastens the uppers to the insole with little wire staples which are made in the machine itself.

Then the Goodyear welt-sewing machine sews a narrow strip of leather, called the "welt," all around the forepart of the shoe, attaching it to both sides of the heel. After this all the staples can be taken out by the insole-tack-pulling machine; and now the welt and the insole can be coated with rubber cement, and the heavier outsole can be pressed into its place. The Goodyear stitching machine sews the outsole to the welt with a strong lock stitch which does not go inside the shoe. This leaves the inside perfectly smooth. The heel is fastened on with nails, and all the nails are driven in with one blow. Finally the shoe gets a variety of trimming and scouring and buffing to give it the high finish that is desired. Of course these last operations vary greatly according to the kind of shoe that is being made.

All this is very interesting to see. What is more, it offers one of the best examples that can be found of organized industrial service. No industry in America has advanced with faster strides than that of making shoes.

This old Indian woman was photographed at Lake St. John, Quebec. She is plying an age-old craft of her race. For without his snowshoes the Indian would often have perished when the deep snows of a northern winter kept him from stealing through the forest on moccasined feet in search of game.

Photo by Canadian National Ry.

Reading Unit No. 7

HOW DOES SKIN TURN INTO LEATHER

Note. For basic information not found on this page, consult the general Index, Vol. 15.

For statistical and current facts, consult the Richards Year Book Index.

Interesting Facts Explained

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Why must skins be tanned?
Why are some layers of animal skin not fit for leather?
How is leather obtained from skins?

Picture Hunt

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How is leather used for other purposes than for shoes? 9-72

Leisure-time Activities

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Summary Statement

The skins of billions of creatures—cattle, calves, horses, sheep, and other mammals, as well as birds and reptiles—are tanned every year to supply the world with its leather.

The faithful cow and her calf give us most of our leather. Yet it would never pay to raise cattle for their skins alone. That means that when we do not eat enough beef we do not have enough leather.

Photo by J. C. Allen

HOW DOES SKIN TURN *into* LEATHER

And What Makes One Piece of It into a Sole, Another into a Glove, and Another into a Chamois?

EVERY piece of leather that we ever wear or use has been worn by some animal before us. It was his skin. We have no way of making leather except from the skins of certain animals.

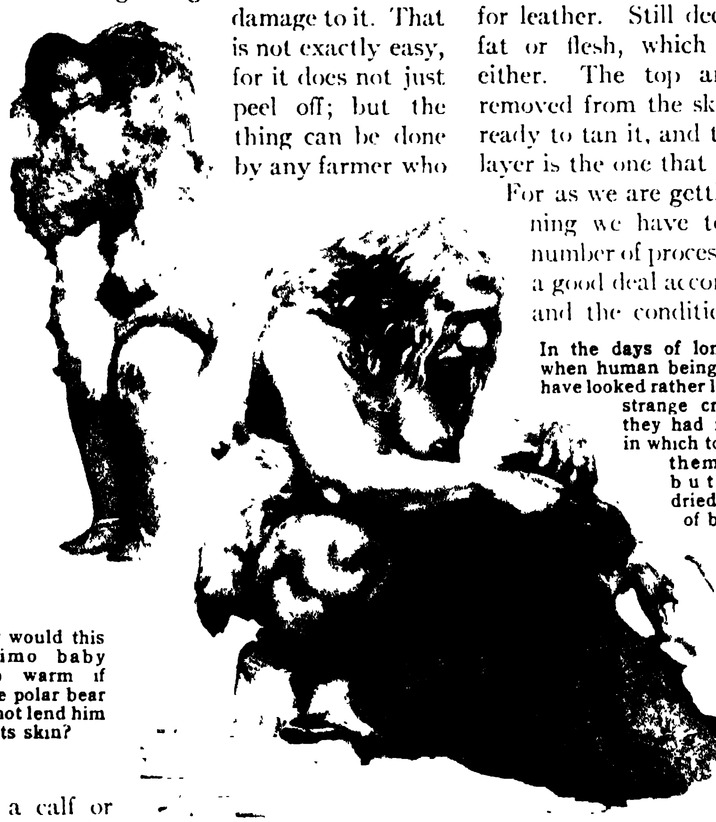
We can use the skins of rather more animals than most people think. The tame animals furnish most of it, of course cattle and their calves, and horses, sheep, goats, and hogs. But some of it comes from wild animals, both on the land and in the sea—from the deer and their relatives, from buffaloes, from alligators, walruses, sharks, and whales. Mostly their skins are used for rather special purposes, as are also those of snakes and lizards and even frogs. In other lands still other animals are used, such as camels and elephants and ostriches, and the kinds of leather we make out of their skins are even more numerous than the kinds of animals.

Of course we cannot use the skin of an animal just as it comes off his back. It would soon decay and go to pieces, and needless to say it would not be a very pleasant thing to have around while it was doing so. We have to treat the skin in some way to keep it from decaying, and at the same time to make it fit for the use to which we are going to put it. What we do to the skin to keep it from decay is called "tanning." We may tan it with the hair on, and then we have fur; or we may take off the hair in tanning, and then we have leather. So the story of our leather is mainly the story of tanning.

Tanning is a very old art. Long before history started it was found out by the wild men who used to keep themselves warm in the skins of the beasts they had killed. At first they must have tanned the whole skin with the fur on it, and have simply wrapped it around them. It was warmest with the fur. But in due time they found out that if they took off the fur they could use the leather in many other things than wraps—for instance, in shoes, into which the great part of our leather goes to-day. And as time went on, they found out better and better ways of tanning, and more and more methods of making the skins into all the different kinds of leather they needed—tough and stiff for the soles of their shoes, thinner and more flexible for the uppers, and still thinner and more flexible for their gloves. So they learned to make leather in scores of

different forms, running all the way from tough harness to soft chamois; and the story of all these is the story of the skins they chose and of the ways they tanned and treated them.

The first thing is to get the skin off without damage to it. That is not exactly easy, for it does not just peel off; but the thing can be done by any farmer who kills a calf or by any hunter who shoots a deer. It is now done more expertly by the workmen in the great stockyards, who give us most of the stuff to make our leather. If the skin is sent at once to the tannery it is called "green." If it has to wait a while, it must be treated in some way to keep it from decay. One way is to dry it thoroughly, another is to salt it. The object of both is to keep out the microbes, which cannot work in a dry thing or in salt; and where there are no microbes there is no decay.



How would this Eskimo baby keep warm if some polar bear did not lend him its skin?

In the days of long ago, when human beings must have looked rather like this strange creature, they had nothing in which to clothe themselves but the dried skins of beasts.

Photos by Field Museum and American Museum of Natural History

Clad in skins, the primitive hunter goes forth with his bow and arrow to shoot more leather for himself against the coming winter.

Three Skins in One

Not all of the skin that comes off can be used for leather. For the skin of every animal, like our own, is made up of three separate layers. On the outside there is a thin layer called the "epidermis," (ĕp′ĭ-dûr′mĭs), which peels off very easily, as we have all noticed. This is unfit for leather. Underneath it is a thicker layer known as the "derma," or true skin; this is the stuff for leather. Still deeper there is a layer of fat or flesh, which is not fit for leather either. The top and bottom layers are removed from the skin when we are getting ready to tan it, and the thick, strong middle layer is the one that is tanned.

For as we are getting skins ready for tanning we have to put them through a number of processes. The processes vary a good deal according to the kind of skin and the condition in which it comes whether green or dry—and also according to what we are going to do with it. But they all consist mainly in soaking the skin in various baths, with or without chemicals, and then of getting off the epidermis and the hair from one side and the fatty flesh from the other. Then the derma is ready to tan. But in the meantime the hair and flesh are not wasted. The hair may be used in making cloth or felt or plaster, or in various other ways, and the flesh goes into such things as glue

Photo by the National Museum

Here is a family of Sioux Indians tanning a buffalo hide. You will notice that the father is merely locking on; practically all the work of preparing leather among the Indians was done by the women. And they did it very well, too. Although they knew nothing of bark tanning, they had worked out an excellent process of dressing soft leather--the "buckskin tan," which the white settlers were very glad to learn from them.

and gelatine. Unfortunately it is not a very nice business, and tanneries are not very pleasing to our noses.

After all this the derma is tanned, and there are several ways of tanning, each with many a minor variation to give us just the kind of leather we want. But the three main ways are tanning with tannic acid, which we usually get from the bark of certain trees; with certain mineral products, usually of the metal chromium (krō'mĭ-ŭm); and with certain oils, usually coming from some kind of fish. Thus for our three ways of tanning we go to the three great kingdoms of nature—animal, vegetable, and mineral.

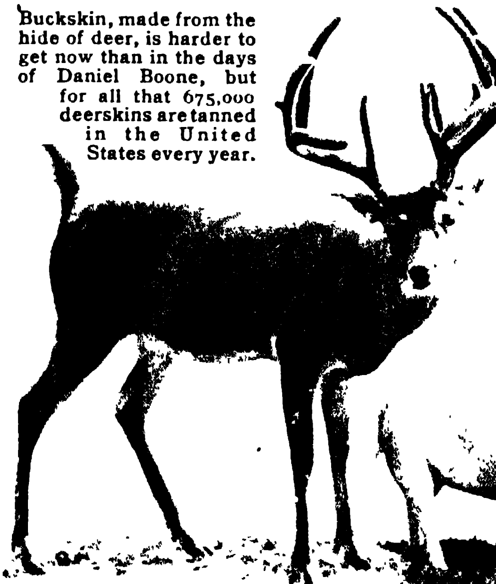
The Bark That Tans Our Leather

The vegetable way is doubtless the oldest, and is still in very common use, especially for heavy leathers. We can get the tannin, or tannic acid, for this from many trees and plants. Mostly we take it from the bark of oak and hemlock, but chestnut, larch, and willow are also used, with a great many other trees and plants, or their fruit or seed, from various lands—gambier from the Malay countries, mimosa from Australia, myrobalans from India, quebracho and divi divi from South America, and the familiar galls from oak trees anywhere. Sometimes the chemists make our tannin for us, and then it is called "synthetic" (sĭn-thĕt'ĭk).

Three Months to Tan a Skin

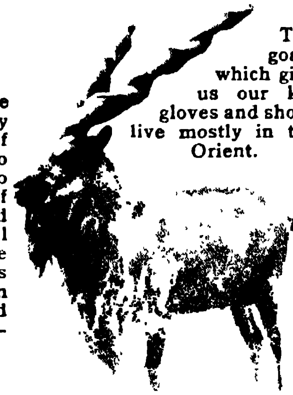
We fill a series of vats with water containing tannin, and throw in the skins. Day by day we move them from weaker into stronger solutions of the tannin, and from time to time we stir them a bit and take them out to drain, only to throw them back again. At last we leave them to soak a fairly long time in the strongest solution. From first to last this takes about three months. Then the skins are tanned.

For mineral tanning we can use several substances. Alum is one of them, and has been used for a long time, but chromium has now come to be the chief thing. It is used mainly for lighter leathers, like those intended for the uppers of shoes and for gloves. Here the skins are commonly "pickled" first in a chemical bath to make them porous, and then they are treated to a solution of chromium salts. The whole



Buckskin, made from the hide of deer, is harder to get now than in the days of Daniel Boone, but for all that 675,000 deerskins are tanned in the United States every year.

Footballs are not the only things made of pigskin. Yet so difficult is it to get the hide off properly and clean it well that almost none of the pigs slaughtered in the United States are skinned at all.

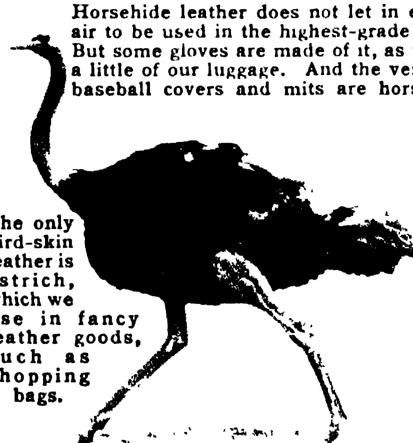


The goats which give us our kid gloves and shoes live mostly in the Orient.

Sheepskin is a spongy leather, particularly good for gloves and other light garments.

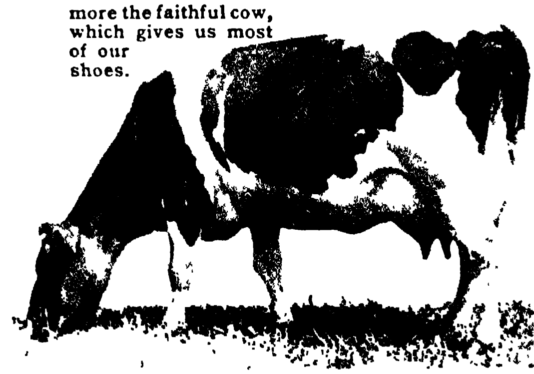
In the old days both Indians and white men made excellent leather from buffalo hides.

Horsehide leather does not let in enough air to be used in the highest-grade shoes. But some gloves are made of it, as well as a little of our luggage. And the very best baseball covers and mits are horsehide.



The only bird-skin leather is ostrich, which we use in fancy leather goods, such as shopping bags.

And last we have once more the faithful cow, which gives us most of our shoes.



Photos by N. Y. Zoo, J. C. Allen

process is much faster than vegetable tanning, taking only about a third of the time. It has been in use only since 1884. The chrome (krōm) leather that it gives us will endure more heat and wet and destructive chemicals than the leather that is tanned by the vegetable process.

Oil is much older in tanning than chromium. It is commonly a fish oil, usually cod-liver oil. The process is not a simple one, but the main idea is to take out all the moisture in the skin and put the oil in its place. The oil, in turn, disappears. This process is used for chamois and other soft leathers.

A very new tanning process uses certain resins that go into plastics.

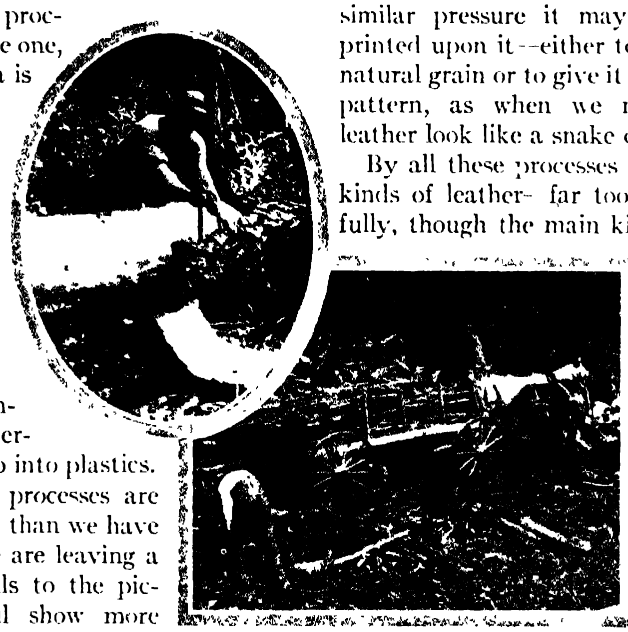


Photo by U S Forest Service

Most of the tannin used in American tanneries comes either from the bark of oak or hemlock, or from chestnut wood. In the oval is a man peeling the bark from an oak, and in the square, men are delivering a load of chestnut. Thus from California to Georgia the leather industry takes men into the great woods.

Now all these processes are more complicated than we have said here, but we are leaving a good many details to the pictures, which will show more than is easy to tell. There are many of these details in each process, and all of them need great care and skill: and the pictures will show some of the cunning machines that are used in the work and that save so much labor.

Even when the leather is all tanned, there is still much else to do. It has to be dried, and that leaves it coarse and stiff. So it next has to be "curried" to make it softer and more flexible; and currying consists in rubbing in the right amount of grease. Then it must be dyed, and this may leave it almost any color—not only the familiar black or tan, but white, red, blue, or any other color, gay or somber. It also goes through a number of other processes, depending on what kind of leather it is to become. If it is meant for soles or harness, it must be made very tough and firm; so it is put under great pressure in machines that roll it or hammer it. If it is to be thin and soft, the hides will have been split into fairly thin layers; and these are now further treated to make them as pliable as we want them.

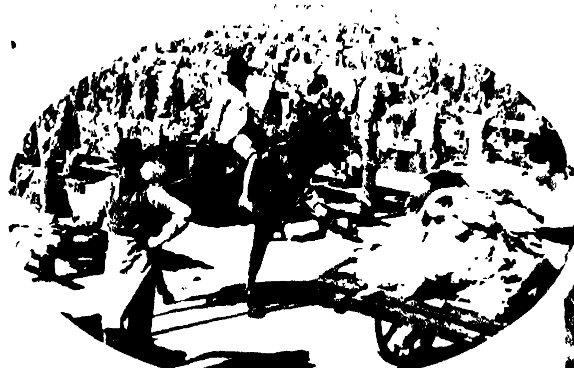
If the leather needs a high polish, as in the uppers of most shoes, it is first treated to a polishing mixture and then "glazed" by a glass cylinder which rapidly rubs it to a fine finish under high pressure. Under similar pressure it may have any design printed upon it—either to bring out its own natural grain or to give it some very different pattern, as when we make an ordinary leather look like a snake or alligator skin.

By all these processes we get our various kinds of leather—far too many to mention fully, though the main kinds may be given.

About four-fifths of all our leather goes into shoes. The rest goes into upholstering for furniture and automobiles and other things, into belting, straps, harness, traveling bags, clothing, bookbindings, and many other objects.

The cow and her calf give us most of the leather for men's shoes, and cowhide is the main thing for all heavy and strong leathers. The goat and the kid furnish much of the leather for women's shoes and for gloves. According to the treatment and finish, cowhides and calfskins may be made into such popular brands of leather as box calf, wax calf, willow calf, gun-metal calf, suede, and several others. The horse originally gave us the leather known as "cordovan" (kôr′dô-văn), a very strong brand which took its name from the town of Cordova, in Spain, where it was first made; but this is now turned out in many places, and often from cowhide. In fact, a good many leathers are not exactly what they are called. Chamois was first made of

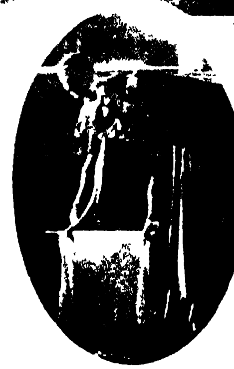
THE STORY OF LEATHER



From all over the world the skins come in to the tanneries. Sometimes they come from the tropical jungles or the farthest steppes of Siberia. But oftener they come from the nearest stockyard. In the oval to the left are many thousands of hides drying at a packing house in Uruguay. When they are ready they will be shipped off to be tanned and made into suitcases and shoes.

When they leave the lime vats, the skins go through machines which scrape off most of the hair. The men in the foreground of this picture are finishing up the process by hand.

At the right are great piles of "green" hides on their way to the vats where they are washed and soaked in a lime solution to loosen the flesh and hair.



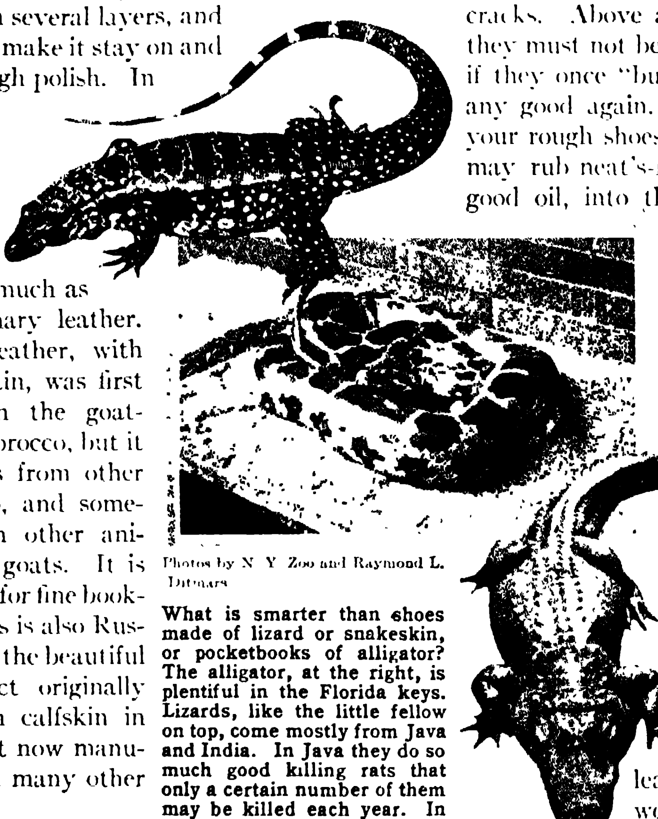
When the skins are perfectly free from flesh and hair, they have to be washed clean of all lime before they can go into the tanning vats. In the oval some of these cleansed skins are being hung up to dry. Next will come the tanning proper—the steeping in a solution of tannin.

After tanning, the leather is dried, and machines stretch and smooth it, as at the left. Most finished leather goes into simple things like shoes, but occasionally some craftsman turns out beautiful handwork like the tooled leather on the chest below. In the circle above is a bit of skin from a prehistoric beast named a trachodon.

Photo by Endicott Johnson Co.

the Alpine animal of that name, but it is very hard to get a piece now that ever saw the Alps; nearly all chamois now comes from the sheep. In the same way buckskin originally came from deer but is now mostly calf or kid. "Pigskin" comes largely from peccaries that grow in South America.

Patent leather is merely leather with a thick, bright coat of glaze or varnish. This is put on in several layers, and is baked to make it stay on and give it a high polish. In the process the leather gets so dry that it will not give or stretch so much as most ordinary leather. Morocco leather, with its fine grain, was first made from the goatskins of Morocco, but it now comes from other places also, and sometimes from other animals than goats. It is much used for fine bookbindings, as is also Russia leather, the beautiful red product originally made from calfskin in Russia, but now manufactured in many other places.



Photos by N Y Zoo and Raymond L. Ditmars

What is smarter than shoes made of lizard or snakeskin, or pocketbooks of alligator? The alligator, at the right, is plentiful in the Florida keys. Lizards, like the little fellow on top, come mostly from Java and India. In Java they do so much good killing rats that only a certain number of them may be killed each year. In the square is a python, one of the beautiful but deadly snakes which men risk their lives to hunt for leather.

Fancy leathers are made from a great variety of skins. The beautiful patterns of alligator skin are seen fairly often in traveling bags and other things, and those of the snake and lizard are not uncommon in women's shoes. Other novelties come from seals and frogs and ostriches, and go into articles such as purses, hand bags, cases for toilet articles, and a large number of other things. And of course we have learned to imitate the skins of the rarer creatures by clever treatment of the commoner skins.

All our leather things will last a great deal longer and look a great deal better if they get fair treatment. We often abuse them rather more than most of our goods. Shoes should not be worn day after day, but should be alternated; in this way three pairs will last more than three times as long as one pair. When not on the feet they should have forms put into them to keep out ugly wrinkles which will finally become cracks. Above all, when they are wet they must not be dried too near the fire; if they once "burn" they will never be any good again. If you want to keep your rough shoes from getting wet, you may rub neat's-foot oil, or some other good oil, into them; but do not treat your fine shoes in this way, or they will never take a polish well afterward. Belting and harness—a rapidly disappearing form of leather—should be carefully oiled from time to time to keep them in good condition and to make them last.

For lovers of fine books, one of the most distressing things about leather is the way bindings wear out—peeling off and cracking at the joints. But the bindings can be saved for many a year by rubbing them once in a while with a little castor oil or neat's-foot oil—just a very little, and never enough to show or feel.

The United States does a vast business in leather, leading all the other nations in this industry, though of course hides are produced and made into leather in every country of the globe. We have hundreds of tanneries in this country, and every year they handle the pelts of many millions of cattle and of calves—to say nothing of the skins of the other animals that are used.

The STORY *of* WOOL

Reading Unit
No. 8

WHY WE STEAL THE SHEEP'S COAT

Note: For basic information not found on this page, consult the general Index, Vol. 15.

For statistical and current facts, consult the Richards Year Book Index.

Interesting Facts Explained

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The best wools, 9-75
Australia, the great sheep raiser, 9-76
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The work of the shepherd, 9-76-79
Shepherd dogs, 9-78
Shearing wool, 9-81
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Things to Think About

How is wool adulterated?
Why must wool go through many types of treatment before it is ready to be spun and woven?
Why do sheep need constant protection?
How is wool waterproofed?
How would you improve on wool?

Picture Hunt

What are some important breeds of sheep? 9-75-77
How is the sheep's coat changed into wool thread? 9-80

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What is the difference between wool and cotton clothing? 14-550
What kind of wool is obtained from the island of Shetland? 6-480
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Practical Applications

How is woolen cloth prevented from shrinking? 9-81
What decides the breed of sheep to be raised? 9-76

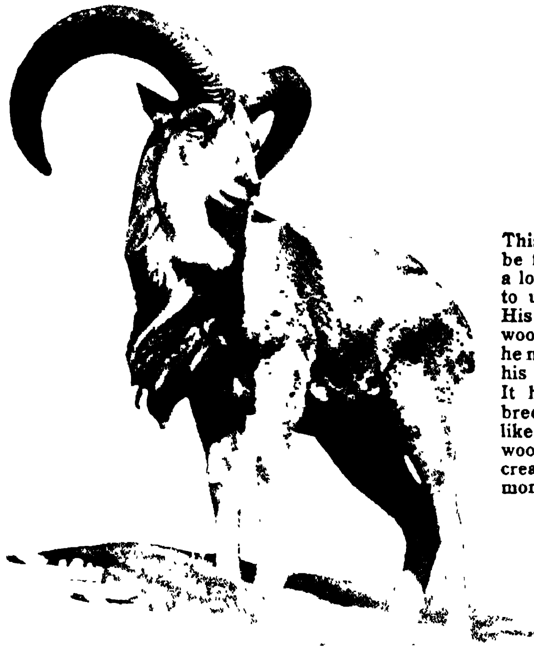
Leisure-time Activities

PROJECT NO. 1: Visit a weaving mill or an exhibit of looms in operation at a museum.

PROJECT NO. 2: Spin some lamb's wool into thread. 9-40.

Summary Statement

No animal grows better wool than the sheep, and no other stuff makes better clothes for cold weather than does wool.



This wild ram, which is still to be found in America to-day, is a lordly creature but not useful to us either for wool or meat. His coat is made of hair, not wool; his legs are long, so that he may outdistance his enemies; his body is tough and sinewy. It has taken years of careful breeding to change wild sheep like this one into the fat, heavily-wooled, rather stupid-looking creatures that bring so much money to their owners to-day.

Photo by N. Y.

WHY WE STEAL *the* SHEEP'S COAT

How His Wool Has Kept Us Warm, and Also Made History for Us—and Even a Great Deal of Poetry

THE fleecy stuff that grows on a sheep's back is not exactly hair. It is curlier than most hair, and it clings together far better. We call it wool. No other animal can rival the sheep in growing it, and no other stuff can rival it for making clothes —at least for cool weather. So the sheep is one of our most important creatures.

Nobody knows where the sheep came from. All of our tame sheep may have come from a single species, or they may have come from several different species; for men saw the importance of the sheep and so tamed him long before they began to leave any records of what they were doing. They were spinning and weaving his wool into clothes long before they were writing, and the sheep may possibly be the first animal they ever tamed. There are still wild sheep on four of the continents of the globe—Asia, Africa, Europe, and North America—though there are none in South America or in Australia. Mostly they are very easy to tame. But the wild sheep do not bear a great deal of wool—it is mainly hair—and that fact leads us to believe that the main reason why our tame sheep give us so much wool is that they have been carefully chosen and bred for it for many a century. In fact, a good sheep at this day may grow a third more wool than his ancestor of only fifty years ago.

Of course we hear a great deal about sheep among the old Greeks and Romans, for the animals had long been valuable. They were already being raised among the half-wild men in England when Julius Caesar came there, and the Romans set up a weaving industry in Britain. From that day until now, the raising of sheep and the weaving of cloth has been one of the main things that have made England a rich nation. Until very recently there was no other business in the land that employed so many people and brought in so much money. In fact, the history of England is in very large measure the history of wool—more

so than that of any other land. That is the reason why the chancellor of the House of Lords always takes his seat on a woolsack, as he has done for centuries.

Where Our Best Wool Comes From

During all those centuries the British sheep have been famous for the length of their wool. There are many breeds of them Cotswolds, Lincolns, Leicesters, Southdowns, Oxford Downs, Hampshires, Shropshires, and still others--and all of these have particular advantages and are especially fitted to flourish in particular parts of the country or of other countries. For they have all been taken into other lands and bred there. And as the English have long raised fine sheep, so they have long woven the finest woolens in the world. To this day they make the best woolen cloth we can get; and the best clothes in America are woven on English looms, whether from fleeces grown there or imported from somewhere else probably Australia.

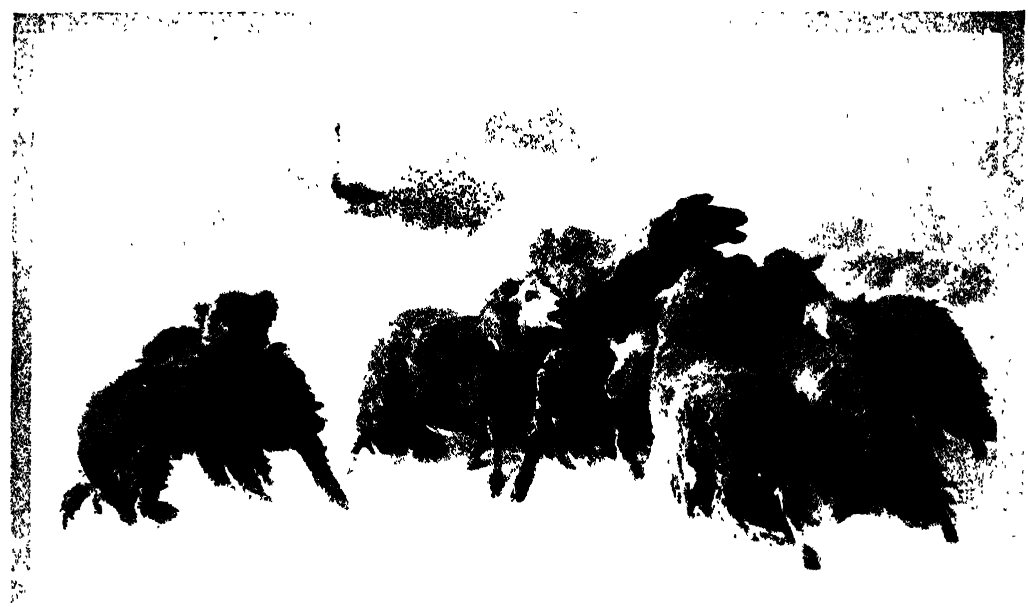
But if British wool has been the longest in the world, it has not been quite the finest. All down through the centuries the wool of the merino (mĕ-rē'nō) sheep in Spain, though a good deal shorter, has been of even finer quality, and this sheep is doubtless the most famous one in the world. From the Spanish merino and from the various kinds of British sheep, in great part, the rest of Europe and the rest of the world have secured sheep of excellent breed. Wherever the sheep have gone they have been constantly bred for more wool or better wool, or both; and also to fit them for the particular land where they were going to live and the kind of food they were going to get there. They can be bred to thrive in a wide variety of climates and countries. In general they are good feeders and can get along where many another tame animal would starve; but some kinds of sheep would die of too little food in places where other kinds will get along very well.

English Sheep Come to America

Thus it was that the merino was carried over into France and bred into the Rambouillet (rôN'bōō'yē') sheep of that land, and taken into Germany, where it grew into the well-known Saxon sheep. In the same way, good breeds spread all over Europe. The French and British sheep went to South America, where they were interbred and founded a great industry The merino went to South Africa and throve. Both the merino and many of the British breeds went to Australia and New Zealand, where there was a vast amount of crossbreeding; and the result to-day is that these countries raise far more wool than any others in the world. Wherever the British have gone they have taken their sheep with them, if the climate would allow it, and in Australia the shepherds have left their cousins in the mother country far behind.

These merino sheep originally came from Spain, but they were taken into Australia and there, by careful breeding, they have been made to give us twice the amount of wool they grew before.

Photo by Australian Government



by Me olitan Mu

This frantic, tangled little flock of sheep is lost in a sudden blizzard. They are so used to being taken care of by their kind shepherd that they do not know how to take care of themselves in an emergency. But if they will only have the sense to obey the dog who is tending them, they will be brought safe home.

In America we have brought in all sorts of breeds—Rambouillet, merino, and about all the British kinds—and have also done a good deal of crossbreeding. As sheep growers we are no rivals for the Australians, since we use so much more of our land for planting than for pasturing; and whereas Australia grows over a quarter of the wool of the world, we grow only about a tenth. Yet our sheep are important. They grow mostly west of the Mississippi, especially in the mountainous country of the center and of the North, and in the Southwest. Texas is the largest producer.

Where We Get Our Mutton

Of course we eat mutton as much as we wear wool, and often the sheep grower has had to decide whether to breed his sheep mainly for their meat or for their fleeces. In the various lands the result has sometimes been a larger sheep with less wool and sometimes a smaller animal with a heavier and finer fleece.

The sheep is a mountain climber. In the winter he will come down into the valleys to keep warm, but in the summer he is off to the heights if he can get there. The wild sheep are found mostly in hilly country, and they have been seen as high as twenty thousand feet up.

"Like a Flock of Sheep"

He is a very silly animal, and a very timid one. He can fight a great battle if he has to, or if he gets his temper up, and if you ever get butted by a big ram you will not want to sit down again for a long time. That is the least that will happen to you. But in general he does not fight. He runs away, or rather, since he cannot run very fast, he huddles together with his mates in a mass such as no other such animals make. No one who has not seen a flock of sheep all huddled together and moving as one animal, whichever way their silly leader may happen to turn, will ever know what we mean when we say that human beings are "like sheep" in the way they run in crowds and just go wherever the crowd is going. But anybody who has ever motored in England will know that when he meets a flock of sheep on the road he may as well stop the car and just wait for the mass of wool to scamper

past him, all jammed together so tightly that it is a little hard to see how they keep their legs from getting tangled.

In a mass like that the sheep are easy prey for any animal that wants to kill and eat them. So from the earliest times the shepherds have had hard and dangerous work in keeping their sheep safe from the wild animals. It is all very easy when you have only a hundred or so sheep all feeding together, and when you are armed with a good gun against the few animals that may be left by the advance of civilization. But it was another matter when there were no guns and far more wild animals, and when there were thousands of sheep in a single herd which had to be guarded day and night, asleep and awake, scattered all over the mountains and often lost in the mists and the snowstorms. Then there was work for heroes, and very skillful heroes at that. Then it was that men like the shepherd who became King David learned the skill with the sling that was to overcome the giant Goliath—the same David that slew a lion and a bear that were stealing lambs from his flock.

And those days of hardy shepherds are by no means over. On the misty mountains and the wild moors of England, where a single wrong step in the fog may take man or sheep into a bog from which he will never rise again, there is still brave work for shepherds. In the mountains of our own West, where the cries of wolves, coyotes, lynxes, and mountain lions still break out in the night, there is need for keen ears and eyes, and for steady fingers on the trigger. In Australia the eye of the shepherd must ever be alert for the dingo and the Tasmanian devil, and also for the thievish natives, or blackfellows. All over the world the shepherd still has a courageous calling.

Photo by U. S. Department of Agriculture

These three rams, weighted down by their thick woolen coats and woolen underwear, will be only too pleased when shearing time comes! Hampshire rams, like the one above, grow to be very tall, and are of more value to the meat market than to the wool industry. The Shropshire ram, in the center, has a valuable fleece of fine long wool, but he is not so sturdy as the Rambouillet ram below, which is bred both for his meat and for his wool.

In all this the best friend of man and sheep is the dog. If he were wild he would eat up the sheep. When he is tame and trained, he will watch over them like a brave stronger brother, though he is a good deal smaller than they are. No other dog is more cunning than a sheep dog, and no other animal in the world is more knowing. He can tell any one of his sheep from those of any other flock, no matter where he finds them by night or day, in sunshine or fog or hail. He will speak to them in his bark just firmly enough to make them obey him and

Some dogs are nothing more than nice pets to play with, but this intelligent collie more than earns his board. One word from the shepherd, his master, will send him scampering off to round up every single sheep.

never sharply enough to frighten them. He can do things with them that no man could do. At a word from his master he will set off into the mountains to collect all the scattered sheep, no matter where they may be lost in a storm. He never rests until he has rounded them all up, every single one. He cannot count, but he knows when they are all there, and he will not come back with a single one missing. He will bring back the whole flock and round them up safely in the sheepfold. Then he will wag his tail a bit and lie down at the shepherd's feet, ready for the next command. If he meets an enemy in the way—a wolf or bear or lion—he will lay down his life before the beast will get at the sheep.

The Faithful Dog and His Flock

When an English shepherd wants the sheep to obey him—and it is no easy thing to make the silly creatures do so—he often tries to bark at them like a dog. He knows well enough that a dog can handle sheep in a panic better than he can. The shepherds breed their dogs as carefully as their sheep; and all over England, in the summer, they have famous contests among the sheep dogs, to see which can win the prizes by doing the most cunning work. No animals in the world are more interesting to watch.

Legends of the Shepherds

Around the shepherd's calling, so old, so vast, and so brave, there has grown up from very early times a great body of legend and history, and even of religion. Abel, the child of Adam, was a shepherd, as were also Abraham, Isaac, Jacob, and David. It was to some humble shepherds watching their flocks by night that the angel choir sang the birth of the Saviour, the Good Shepherd, the Lamb of God. To this day the word "pastor" means simply "shepherd." The Chaldean shepherds who gazed at the stars by night came to be our first astronomers. A race of shepherd kings once ruled all Egypt. The great warrior Tamburlaine, who conquered half the world, began life as a Scythian shepherd; and many another famous man has come to us out of the pastures of the sheep. For a long while,

Not far from the splendid palace at Versailles is this pretty little grcɹⁿ of thatched houses, clustered around a pond filled with carp. Here Marie Antoinette, whose picture you see, and Louis XVI played at being shepherdess and shepherd. Here they grazed their flock, and here the Queen had her dairy and the King his mill!

indeed, most of the human race used to live a wandering life, as some of them still do, because they simply followed their sheep and other animals around wherever the grass was greenest. That was the "pastoral age" of man.

Poems Inspired by Sheep

So the sheep have done a great deal for history. They have done even more for literature. Somehow when men get into the high life of towns and cities and of courts and palaces, a good many of them begin to look back longingly to the simple days of old—to the peaceful times, seen through rosy glasses, when there was no bustle and worry, no pomp and luxury and boredom and heartache. And somehow they all long to be shepherds again—to live the pastoral age all over. Just why they want to be shepherds rather than hunters or fishermen is not quite clear, but so it is, and so it has always been—perhaps because there is something deep down in our past that calls for it, perhaps just because it has always been a fashionable longing. At any rate the poets long ago began to write a great many pretty verses about the pastoral age of old to which they longed to return.

These pastoral poets made up an imaginary land of "Arcadia" where all the people were noble shepherds and sweet shepherdesses, and wrote many a beautiful poem about their happy lives and their happy or unhappy loves. Thus the pastoral poem grew up in the hands of Theocritus (thē-ŏk'rĭ-tŭs) and Moschus (mŏs'kŭs) and Bion (bī'ŏn) in old Greece and of Virgil (vûr'jĭl) in Rome. And in modern times a real host of poets have vied with each other in writing pastoral poetry of every sort. Some of our most beautiful poems have been pastorals—like the "Lycidas" of Milton and the "Thyrsis" of Matthew Arnold. There are thousands of such poems in all the modern languages. And often the fashion has gone over from poetry into real life. People who were tired of high life have tried to be like shepherds once more, or at least have played at it. Just before the outbreak of the French Revolution, Marie Antoinette, the queen of France, and her lords and ladies made a perfect little farm and farmhouse in the grounds at Versailles where they could play at being shepherds and shepherdesses.

We could talk about all this for the rest of our book, but we must "get back to our muttons," as the famous saying has it. We have seen how the sheep have spread all over the world and have been made to give us more and more wool. Now we must say something about how the wool is made into

THE STORY OF WOOL

Courtesy Australian News and Information Bureau

Top: Australian sheep are brought in to be shorn. Center left: Under the shears the greater part of the fleece comes off in one piece. Center right: While one worker (left) "skirts" the fleece to remove the poor wool from underneath the body, another man (right) classifies it as to grade. After the wool has been carded and combed, it is washed and dried in the machine at the bottom left. In long strands, or "slivers," it is then fed into the machine at the right, which will lay the fibers straight as they pass over its wire combs.

the clothes we wear. But on this point we are not going to be quite so long-winded, because the pictures will tell the story better than our words.

How a Sheep Is Sheared

Every spring the sheep has his wool cut off, and in warm countries he may have it cut more than once a year. It is first cut when he is about eight months old, and it is then "lamb's wool." The shearing is good for him—it makes him cooler in the hot weather. A man who shears him by hand can take the wool off all together, almost like a skin, and bundle each sheep's wool up separately in this shape, to be sent to the factory. And that is convenient at the factory, for there the wool has to be sorted for quality—the best from the sides and shoulders, the poorest from the other parts of the body. On the big farms the shearing is done by machinery. A man can shear some twenty-five or more sheep a day, but a machine may take care of as many as two hundred.

Often the sheep get a bath or two, and a swim, before they are sheared, to clean the wool. But even so the wool has to be very thoroughly and carefully washed again, to take out all dirt and especially to remove the natural grease. The grease that comes out is called "lanolin" (lăn′ō-lĭn). It is what kept the sheep from getting wet through while he was wearing his fleece, and it is what you can use to waterproof your own woolen coat if you care to. You just put back the oil the sheep used to have. Of course all the washing is done by machines, as is almost everything else in the wool industry. But it needs expert watching all the time.

How Wool Is "Teased" and "Burred"

When the wool is dried again it has to go through a large number of processes to make it ready for spinning and weaving. These processes may vary a good deal according to the kind of wool and still more according to what we are going to make of it. It is "teased" to take out any tangles. It may be "burred," with machines and chemicals, to remove burs or knots of any sort. It is blended to make a good combination of wools for the same piece of cloth, or to mix it with any other kinds of stuff that are to be woven with it—cotton, silk, or what not. It is oiled once more to make it as pliant as it was before the natural grease was taken out, or more so. It is "carded" to straighten out the fibers for the spinning. It may be combed for further straightening. And there are still other operations that it may undergo, all of them done by big machines. The pictures will show you these machines at work.

Making Wool into Cloth

Then the wool is ready for spinning into threads and weaving into cloth. Wool is easy stuff to spin and weave, and we have elsewhere told how spinning and weaving are done with any kind of fibrous substance. The wool may be dyed to any color, either before spinning or after weaving. After the cloth is woven it must be shrunk, or else the clothes made of it will be much too small for us after they have once been wet. But if it is shrunk in the mill it will always fit us. Then the fine ends of the "nap" are all pulled up by a machine which makes them stand erect on the cloth, and finally these are all mowed off evenly by another machine, just about as the grass is mowed on the lawn. The cloth is now pressed and dry-steamed, and all is done.

It is fine and beautiful woolen or worsted, the pride of the loom. No other cloth is so good, except in hot countries, where cotton is better because cooler. Much woolen goods is mixed with cotton or sometimes silk, or with woolen waste from the mill or from the ragman. The last is called "shoddy." It is hard to tell how much or what type of wool went into a fabric, but by law woolen articles must be labeled with the information.

The world produces over three and a half billion pounds of wool a year, with Australia, Argentina, New Zealand, the United States, British South Africa, and Uruguay leading among wool-growing countries. In the United States Texas grows the most, with Wyoming and Montana coming next.

Reading Unit
No. 9

HOW WE CAN BEAT THE SILKWORM

Note: For basic information not found on this page, consult the general Index, Vol. 15.

For statistical and current facts, consult the Richards Year Book Index.

Interesting Facts Explained

Viscose, 9–83
Chardonnet, 9–83
Rayon, 9–83, 86
Dyeing artificial silk, 9–86
Silk from wood and cotton, 9–86
Composition of cellulose, 9–86
Spinning thread from a chemical compound, 9–86
Lace and net made without weaving, 9–86

Things to Think About

How is it possible to produce cloth without using looms?
Why is rayon replacing silk?
Which stage of the rayon process resembles the work of the silkworm?
Which is more needed, artificial silk or artificial wool?

Picture Hunt

How is wood turned into viscose? 9–84
How is viscose turned into a finished thread? 9–85

Related Material

How is silk made into cloth? 9–42-44
How did Pasteur overcome the silkworm disease? 13–368
How are silk rugs woven? 12–156
How is thread spun? 10–339-42
How does regular spinning and weaving resemble the spinning and weaving of rayon? 10–339-46
How is cotton made into cloth? 9–27-34
What are the products made from cellulose? 9–293
Why are we able to make rayon from plants? 9–86, 2–40

Practical Applications

What countries have been most affected by the growing popularity of artificial silk? 9–37-38
What are the materials into which rayon may be woven? 9–86

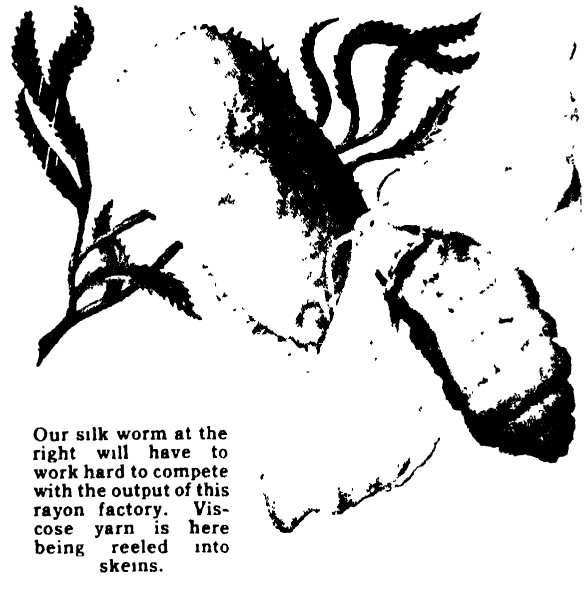
Leisure-time Activities

PROJECT NO. 1: Dye some silk and some rayon, to test the ability of each to take dye.

PROJECT NO. 2: Spin some rayon floss into thread, 9–46, 2–224.

Summary Statement

Wood and cotton can be changed into a cheap and lasting artificial silk. The manufacture of artificial silk is an important industry.



Our silk worm at the right will have to work hard to compete with the output of this rayon factory. Viscose yarn is here being reeled into skeins.

E. I. du Pont

HOW WE CAN BEAT *the* SILKWORM

In Learning How to Make Rayon, We Found Out How to Have All the "Silk" We Want, at a Much Lower Price

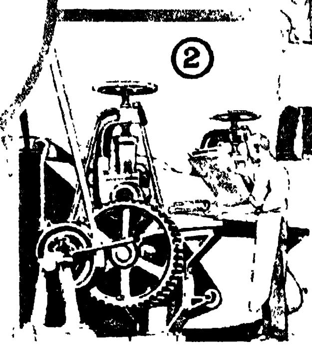
OR thousands of years certain men have had to spend their time feeding and tending millions of little worms in order to coax them to spin the silk that everyone prizes so highly. It was slow and tedious and expensive, but people wanted the silk and there was no other way to get it. And then one day a clever Englishman named Robert Hooke said to himself, "It really is very tiresome that we should have to wait for the worms to make all our silk for us. How much better it would be to use their process and so make as much of our own as we like!" He made his suggestion public in 1664, but it was some two hundred years before anything much was done about it.

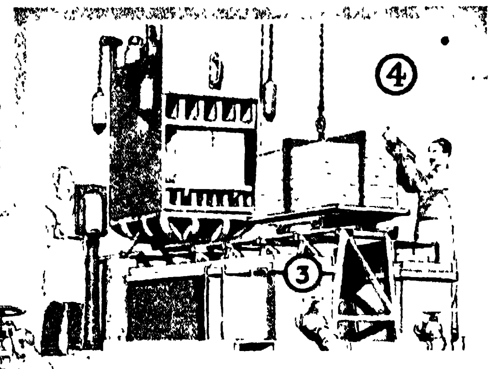
At last a young Frenchman, Count Hilaire de Chardonnet (ē′lĕr′ dē shär′dō′nĕ′), working as a student of the famous Pasteur, grew interested in the subject, and after some thirty years of work patented (1884–85) a process for making "silk." About the same time Joseph Swan produced in England a fabric of the same sort by a different method. But though Chardonnet built a factory to turn out his invention, these fabrics were very expensive to make. It was not till two English chemists, Cross and Bevan, discovered what is known as the viscose (vĭs′-kōs) process that the new goods could be made and sold cheaply. Nowadays we use the acetate (ăs′ē-tāt) and Bemberg processes as well. Acetate, which is described on another page, shines or even melts when ironed at a high temperature, but it does not soil or crush easily.

Whatever the process, "artificial silk" is now a very good fabric indeed, exceedingly durable, almost like silk in appearance, and very much cheaper. It is no longer thought of as an imitation or a makeshift.

It has a name of its own and a place of its own in our homes and shops. It is called "rayon," and we buy it, not simply because it looks like silk and is cheaper, but because it is beautiful and durable and serves our purposes so well. It is even better than silk

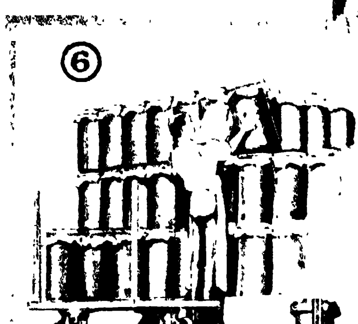
2. The wood pulp is wet and pressed into mats, so that it may be handled easily.



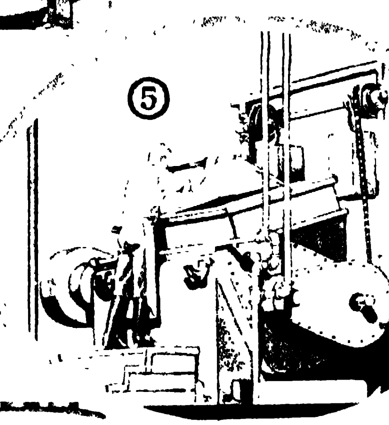


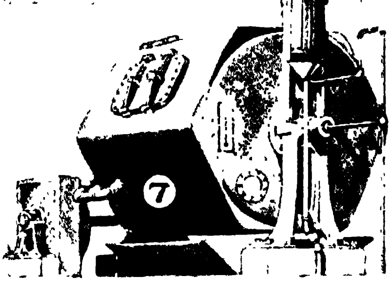
1. The first step in making rayon is to cut the spruce trees which yield cellulose, the basis of the whole process.

3. The mats are put into a bath which produces "alkali cellulose." Then (4) they are put into a press which squeezes out all the moisture.

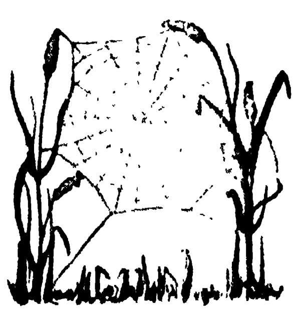


5. Powerful grinders in the shredding machine turn the mats into cellulose "crumbs," which are packed in cans (6) and aged for three days.





7. Then the crumbs are mixed with carbon bisulphide in a churn, and become an orange-colored mass. 8. This mass, called xanthate, reacts to form a solution of viscose when mixed in tanks with caustic soda.



9. Viscose is aged, filtered, and treated in a vacuum to remove air bubbles. Then it is ready for the spinning machine which will turn it into fibers much like the ones the spider uses to make his web, but much stronger.

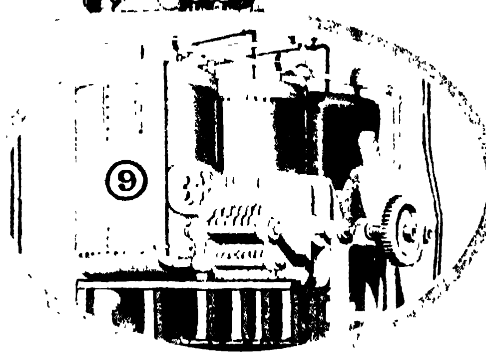
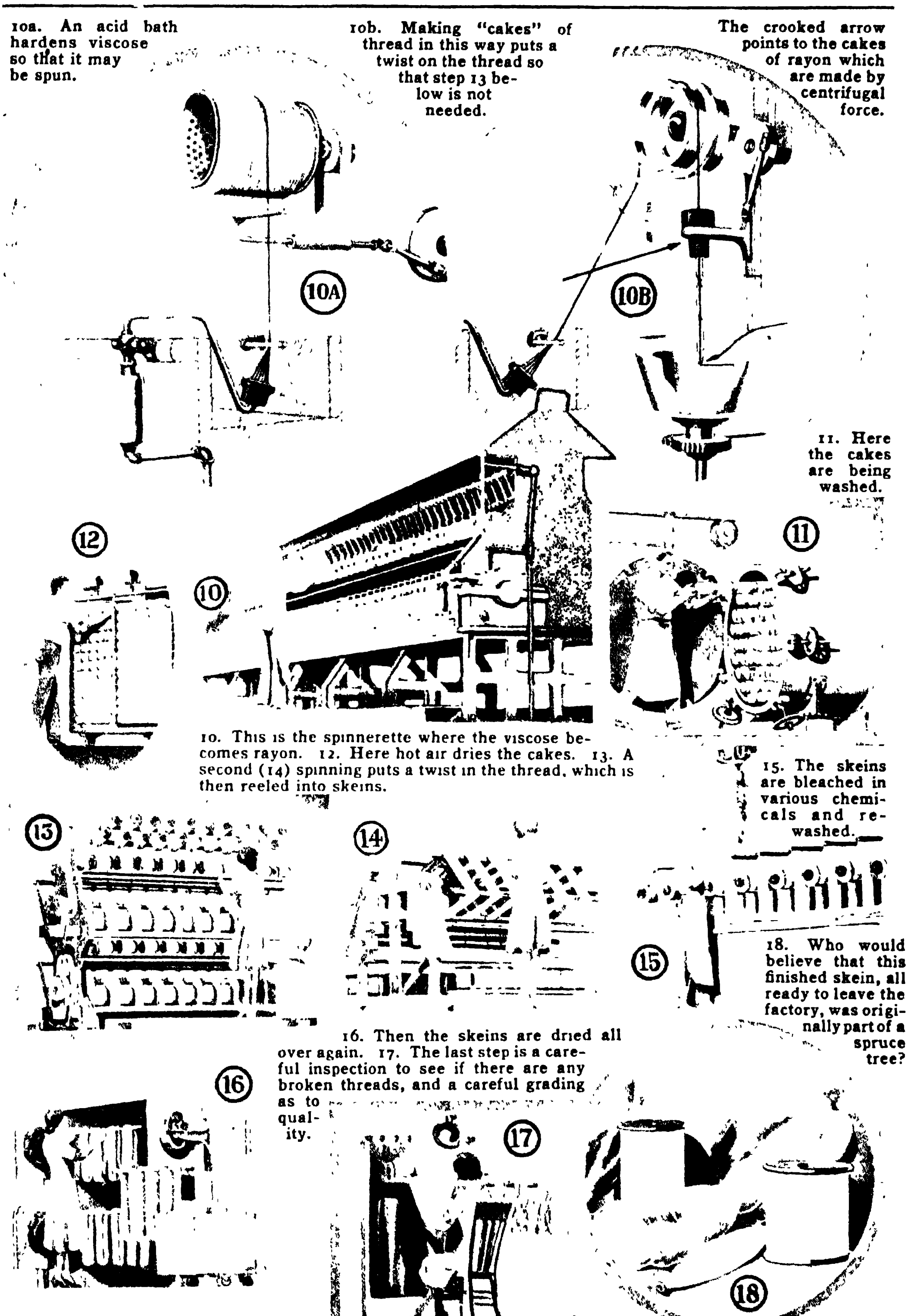


Photo by Courtesy of Popular Science Monthly



10a. An acid bath hardens viscose so that it may be spun.

10b. Making "cakes" of thread in this way puts a twist on the thread so that step 13 below is not needed.

The crooked arrow points to the cakes of rayon which are made by centrifugal force.

11. Here the cakes are being washed.

10. This is the spinnerette where the viscose becomes rayon. 12. Here hot air dries the cakes. 13. A second (14) spinning puts a twist in the thread, which is then reeled into skeins.

15. The skeins are bleached in various chemicals and re-washed.

16. Then the skeins are dried all over again. 17. The last step is a careful inspection to see if there are any broken threads, and a careful grading as to quality.

18. Who would believe that this finished skein, all ready to leave the factory, was originally part of a spruce tree?

Photo by Courtesy of Popular Science Monthly

in taking a dye, and it is made into dress goods and other yard goods, into underwear and stockings, into velvets, draperies, curtains, linings, and upholstery. Often it is combined with silk and other materials. And during World War II it was found to be excellent when combined with rubber to make the casing of tires.

The process by which rayon is made is nothing less than a marvel. Great spruce trees go into the factory and come out as fairylike chiffons or lustrous velvets. Short fibers, or "linters," from the cotton plant are often used, too, in the making of rayon.

Now if we are to do the silkworm's trick we must study its methods. All the silkworm ever eats is the leaves of the mulberry tree, and the silk it spins has to be made mostly of the substance it gets from those leaves. This substance we know as cellulose (sĕl′ū-lōs). It is what makes up the cell walls of all plants--of lettuce, or cotton, or spruce wood—and it consists of three chemical elements, carbon, hydrogen (hī′drō-jĕn), and oxygen. They are the same ones that make up sugar and starch, but they are combined in different ways.

When the wood or cotton arrives at the factory to be manufactured into rayon by the viscose method, it first is turned into a pulp, in a pulp mill. Then, after it has been washed in a solution of caustic (kôs′tĭk) soda to remove all the impurities, it goes through a shredding mill, which breaks it into crumbs. These crumbs are put into a tank containing a chemical known as carbon bisulphide (bī-sŭl′fīd), and the whole is churned for several hours. The chemical turns the crumbs of spruce wood into an orange-colored, lumpy mass called cellulose xanthate (zăn′thāt).

Next, the cellulose xanthate is dissolved in water and caustic soda and filtered—or very finely strained. It is pumped into tanks in a dark room and allowed to stand for some five days, and then is filtered again, several times. Now it is a golden brown and looks like honey. It is called viscose—and is all ready for a machine to step in and do the work of the silkworm—that is, to spin the curious substance into thread.

The device that does this is called a spinnerete. It is a metal cap—made of gold or platinum—full of tiny holes, all the way from 18 to 144 in number and so small that you must have a magnifying glass to see them. The viscose is pumped under high pressure through a pipe leading to the spinnerette, which is fixed at the end of the pipe and is submerged in a tank filled with an acid solution. As the tiny streams of viscose flow through the spinnerette they come in contact with the acid and are jellied or stiffened by it until they are turned to fibers—a good deal like a spider's web, but much stronger. The spinning machine gathers up these tiny fibers and spins them into a thread which it winds on a spool.

This thread is then rewound into skeins and is put through bleaching baths which turn it pure white. After the skeins have been carefully washed and dried they are graded according to color and smoothness and sent to the mill to be woven into cloth.

There is another wonderful machine which makes lace and net directly from the viscose without any spinning or weaving. The pattern of the lace or net to be turned out is engraved in fine grooves on a large steel cylinder. This cylinder is mounted over a tank that contains the same jellying bath which turned the viscose coming out of the spinnerette into fine, silky fibers. Just enough viscose is poured over the cylinder to fill the grooves. The cylinder is then turned around, so that all sides of it pass through the bath, and as it turns, the viscose in the grooves is turned by the bath into rayon. All that is necessary after that is to take the lace off the cylinder, where it has been formed in the grooved pattern.

Nylon, shown on another page, seems like rayon but is quite different. It is made from coal, air, and water, is very strong and light, keeps its shape, will not absorb moisture, needs little ironing, and resists dirt and rubbing. No wonder it is popular!

Though rayon is very durable, certain varieties of it ought never to be rubbed when it is wet. Squeeze the dirt out of it in strong soap suds, and do not hang it where it will be beaten about by the wind.

Reading Unit
No. 10

THE HOW AND WHY OF HATS

Note: For basic information not found on this page, consult the general Index, Vol. 15.

For statistical and current facts, consult the Richards Year Book Index.

Interesting Facts Explained

Things to Think About

How can we get a material from hair without weaving?
Why are genuine Panama hats valuable?
Why do people wear hats?
What would you consider an ideal hat?

Picture Hunt

What kind of hats did the ancient Egyptians wear? 9–91
What kinds of headdress do men wear on the different continents? 9–93
What are the styles of women's headdresses in different parts of the world? 9–98
Which kinds of hats were popular in the United States during the middle of the 19th century? 9–95

Related Material

How do we get fur from seals? 4–327-32
What is the importance of the fur trade of Alaska? 8–11
Which part of the United States was long the chief source of her furs? 7–231
What is the life cycle of the rabbit? 13–361
How do beavers live? 4–373-76
Where does straw come from? 2–180
What is the history of the country which makes Panama hats? 5–500, 507, 517

Practical Applications

How are waterproof hats made? 9–90
How are cool hats made? 9–90

Summary Statement

The different materials from which hats are made, and the different ways in which they are manufactured, present one of the most fascinating stories of modern industry.

Headdresses from many lands: A. Tunis. B. Samoa. C. Japan. D. Norway. E. China. F. Holland. G. Holland. H. Lithuania. I. Palestine. J. An Eskimo.

There's not much in a firm, strong felt to suggest a rabbit's fur; yet it is European bunnies like these that grow the hair from which good felt is made.

The HOW *and* WHY *of* HATS

Why Do You Wear a Hat When You Go Out on the Street? For Warmth, for Beauty, or to Look like Everyone Else?

HAVE you ever stopped to count the hats in any well stocked home? Just try it, and you will be surprised at the variety you will find. Silk hats, straw hats, felt hats, feather hats, caps of rubber or wool or fur, of cotton or linen or lace, and, if we have an athlete in the family, an assortment of queer headgear made of leather or wire or rubber, or even of celluloid.

And we have not yet counted all the strange materials that may go to trim the hats of mother and the girls—glass, cloth, metal, feathers, silk, leather, ribbon, lace, rubber, straw, and even porcupine quills!

With such an assortment as this, it will be easy to see that ships have steamed from every corner of the globe and people have been hard at work in hundreds of factories and shops in order that our family might have their heads covered. If the hats could talk about where they came from and how they were made, they could tell some wonderful tales.

Father's best felt hat might take you first to France or England, where people raise hares and rabbits with a certain kind of fur, from which fine felt is made. This rabbit fur is shipped to the United States—to New York or Philadelphia, or perhaps to Connecticut, for there are hat factories in all these places and in still others. But if father's hat is very fine indeed it will be made, not from rabbit's fur, but from beaver, or perhaps from muskrat or nutria, which is the fur of a little beaverlike animal in Argentina called a coypu. Sometimes sheep's wool is mixed with fur, but this makes a cheaper grade of felt.

When they arrive at the factory, the skins of beaver, muskrat, and coypu, or of hare or rabbit, are thoroughly brushed and cleaned. They are even treated with a chemical which loosens all the tiny scales that cover the outside of the hairs. Those scales stand up like little barbs and help to hold on tight when the fibers are all matted together.

Then, when the fur has been cut away from the skin and sorted and picked and worked, it is pressed, by a very careful process, into the thin, firm mat that we call felt. For that durable material—which early man learned how to make even before he learned to weave—is nothing but a mass of tiny hairs or fibers all firmly welded and matted together under pressure and steam. You see father's felt hat could tell you quite a story of travel and adventure.

And so could the straw hats. The straw from which they are made probably grew in Italy, China or Japan. There it was bleached and braided into interesting patterns, and then rolled into huge bales and sent, perhaps, to Chicago, to be fed into great machines that sewed it round and round until it came out a hat.

The rubber in bathing caps and rain hats may have come from South America. The linen in brother's summer cap was made from Irish flax. The little wool hood the baby wears in winter once clothed the back of a sheep in far-off Australia. And yet we have only just begun to count our materials!

A Mexican hat seller knows that his customers are not fussy, so he spreads his hats out on the pavement, as shown in the oval. In the square is a girl of the Philippines at work braiding a hat.

Photos by Ameri[illegible] Mu[illegible]al History and Bu[illegible] of Educati[illegible]

The most interesting story of all will be told by father's Panama. It must have come from Panama, Ecuador, or Colombia, where the screw pine grew that gave its unopened leaves to be shredded into strands and woven into a fabric as fine as linen. Every one of those strong fibers was some twenty inches long and no coarser than a thread. But the fibers are tough beyond belief! And when they have been painstakingly woven into a soft, firm hat, they are so strong that the hat will last a lifetime, though it is so light that father hardly knows when it is on his head. He is very fond of this hat, which cost him a hundred dollars. It took a brown-skinned workman at least six months to make that Panama! Of course some "Panamas" are very much cheaper. Brother's, for instance, cost only three dollars. But then, it never saw the country of Panama!

Now it is true that Mother Nature did very well by us when she gave our heads a covering of soft, warm hair. But men seem never to be satisfied with what they have! The first man to be struck with the notion of wearing something on his head probably was casting about for some way to impress his neighbors. For primitive men—and, unhappily, even some modern ones—are often quite silly in that way! So the man decked out his head in feathers, or leaves, or dainty shells. And soon it became the style among all those childlike folk to put on what was handy to make themselves look "beautiful."

Finally the fashion got such a start that no one dared go bareheaded for fear of looking queer. And in that we are no wiser than the simple savages, for to-day our chief reason for wearing hats is to look like other people!

After a time men began to spread over the earth into all kinds of uncomfortable climates, and of course they needed head cover-

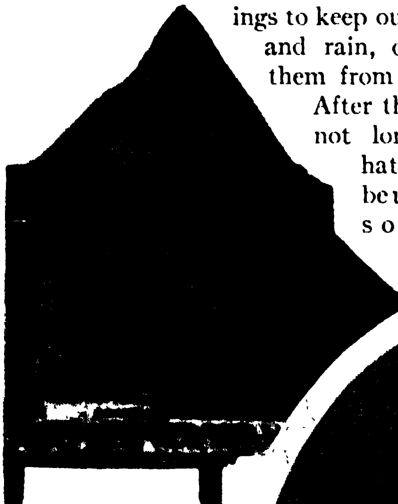
A. Assyrian headdresses, 885 B.C. B. Early Egyptian headdress. C. An Egyptian gentleman.

D. A lady of Ur. E. Egyptian headdress in Roman period.

F. Nefertiti, queen of Egypt about 1350 B.C.

G. Gentleman of Ur

Photos by Rys. of Germany, Visual Education Service, and Swedish State Rys



ings to keep out the cold and rain, or shield them from the sun. After that it was not long before hats came to be used for all sorts of strange

Here are three of the many steps in making a felt hat. During the first part of the process, when the loose felt is shrunken, dyed, and stiffened with shellac, a hat is cone-shaped, like the ones shown in the topmost picture. Then it is dipped in boiling water and shaped over a metal form until its peaked cone is turned into a broad crown and its brim is pulled out all around it. Next it is worked on a wooden block that is just the shape and size the finished hat is to have, and the brim is made to form a sharp angle with the crown. After being smoothed and finished with emery paper, our hat is ready for the lining and trimming which will make it ready to wear.

purposes. They showed a man's rank, since only a king or ruler might wear a crown, and only a bishop his miter. Or they showed a man's occupation—like the baker's little round cap. Or they showed one's past adventures, as when pilgrims wore shells on their hats to show that they had been to the Holy Land.

When Hats Expressed Man's Thoughts

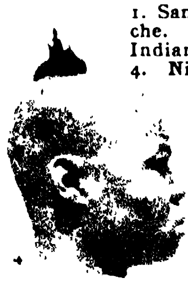
Hats even came to show what a man's opinions were! By looking at his head you could tell what he thought about religion or about political questions. Thus in certain periods the Jews were forced to wear yellow hats of a certain shape, so that everyone might know the wearers belonged to the Jewish faith. And Quakers so commonly wore a broad-brimmed gray hat that they came to be known as "broadbrims."

At one time England was divided into two parties of men called Cavaliers and Puritans. Each party wished to get control of the country, and each party wore a particular kind of hat. A Cavalier set on his curling hair a low-crowned, soft-brimmed hat, with a dashing plume at the side. But a Puritan, who felt that beauty and pleasure were very wicked, wore a solemn hat with a high crown and a stiff, wide brim.

Of course people all along have used their hats to express what they were feeling. For a man to take his hat off has long been a sign of respect. Men take

Photos by John B Stetson Co

1. Samoan. 2. Apache. 3. Menominee Indian, Wisconsin. 4. Nigerian, South Africa.



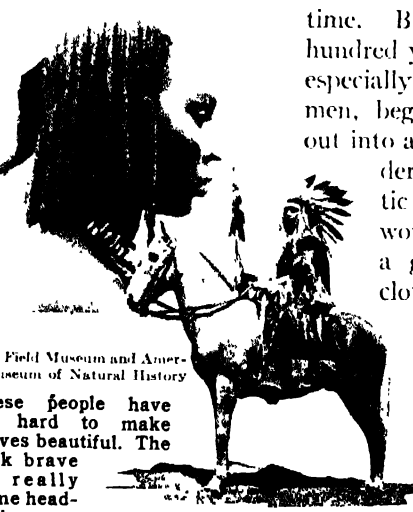
6. Singhalese, Ceylon.
7. Arab sheik, Syria.

5. Sioux. 8. Laplander. 9. Hollander. 10. Singhalese, Ceylon.

off their hats in the house, in church, or on meeting a woman. But interestingly enough, the opposite is true for women. There are many churches where no woman may go with head uncovered.

Why We Have Hat Bands

People have been wearing head coverings for so long, for so many different purposes, and in so many different countries and climates, that it is hardly strange to find that there are hundreds of different kinds. But even then the strange things that people have sometimes put on their heads are hard to believe. The ancient Egyptians commonly wore a band to keep their hair in place. The distant grandchild of that band is with us still to-day. But it is found outside the hat! The kings and queens in Egypt wore tower hats tilting backward, with a serpent fastened in front above the forehead—for the serpent was the special mark of a king or queen.



Photos by Field Museum and American Museum of Natural History

All these people have worked hard to make themselves beautiful. The Mohawk brave has a really handsome headdress, but not quite so much can be said for the three African natives—though if we were members of their tribes, we might feel that they looked very fashionable.

In Assyria a cloth was wound around the head or laid over it like a scarf. Later that loose cloth was fitted to the head with drawstrings, so that it could be pulled down into a kind of cap. And to this day we still carry a relic of that early custom. For the little bow inside men's hats is what is left of that old, old drawstring that drew up to fit the head.

Why We Have Streamers on Our Hats

People who lived four thousand years ago on the islands of the Aegean Sea wore strange cone-shaped caps; and the ancient Hittite kings and queens set upon their heads tall hollow cylinders—not unlike stovepipes. The Hebrews and the Greeks wore caps, but the Greeks and Romans also wore a wide-brimmed hat of felt for strong sunshine or for traveling, and to it were fastened long strings to go under the chin or behind the ears. That is why we still see streamers down behind a hat for decoration.

The Battle of Hats and Collars

Women in Greece and Rome wore veils or hoods, made of wool in winter but of linen in summer. And Spanish ladies to-day wear beautiful lace mantillas thrown gracefully over their heads.

In the earlier Middle Ages hats were fairly simple. Nuns in the Roman Catholic church still wear a hood which was common during that time. But about eight hundred years ago, hats, especially those of women, began to blossom out into all sorts of wonderful and fantastic shapes. What would you say to a great tower of cloth sitting back on the head, with two enormous horns on the sides of it, and from these horns long veils floating off into the air? You might be almost frightened if you met such a hat in the dusk. And yet the ladies of France and England five hundred years ago thought that these fantastic towers made them look more beautiful.

Sometimes, instead of the tower, horns, and veils, a lady might wear one or several huge affairs shaped like baskets perched on her head. Or she might carry an enormous cone upside down, with an immense veil floating away from it. Almost anything large and unusual could be a hat.

There is no telling what enormous structures hats might have become if they had gone on getting bigger. But instead, about

five hundred years ago, people began wearing enormous collars called ruffs, made of starched linen or lace. These enormous collars got in the way of the veils on the enormous hats. So hats grew smaller and smaller to allow space for the ruffs.

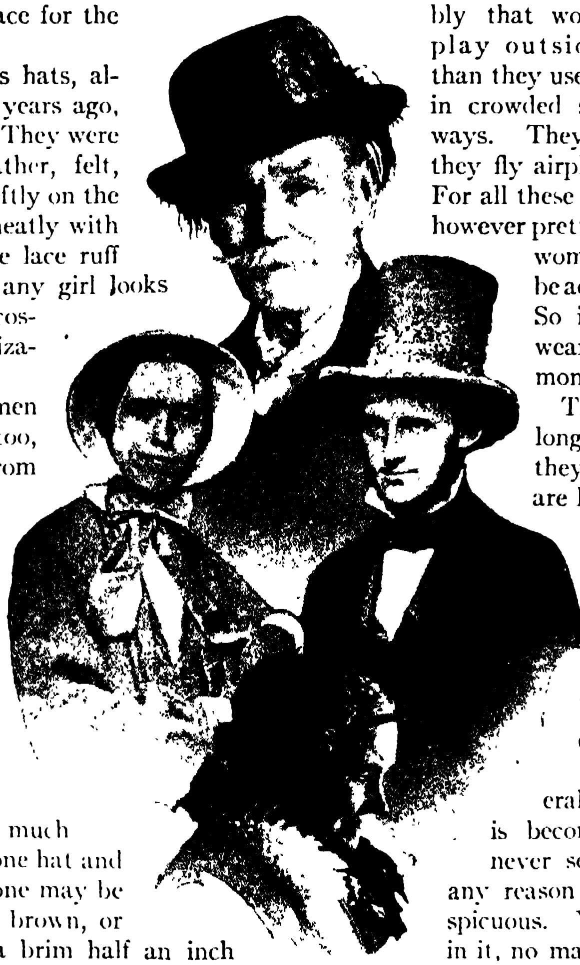
Queen Elizabeth's hats, almost four hundred years ago, were really pretty. They were little things of leather, felt, lace, or net, lying softly on the hair and fitting in neatly with the bold line of the lace ruff or collar. Almost any girl looks pretty in a hat and costume of Queen Elizabeth's day.

At that time men wore beautiful hats too, often of felt made from beaver fur, with a bright plume or a brilliant jewel at one side to hold the brim off the face.

After Queen Elizabeth's time men's hats became less and less interesting and colorful, until to-day there is not much difference between one hat and another, except as one may be gray and the other brown, or as one may have a brim half an inch wider than the other.

Women's hats have kept their color and gayety longer, for one of the chief purposes of women's hats is to make the wearer look more attractive. During the past three hundred years women have worn hats of countless different sorts.

Usually when sleeves have been large, hats have been small; so with the great "leg o' mutton" sleeves of the 1890's went trim little hats, while fifteen years later hats were sometimes two feet across.



In Bavaria the men wear hats like the one at the top of the picture; and in Sweden the peasant women wear knitted hoods like the one on the old lady shown here. The other two persons lived in our own land in its early days, and the woman is wearing the poke bonnet that was then in fashion.

But little by little women's hats have been finding a pattern which is not so very different from year to year. The reason is probably that women now work and play outside the home more than they used to do. They stand in crowded street cars and subways. They drive automobiles, they fly airplanes, they play golf. For all these activities a large hat, however pretty, is a nuisance. And women nowadays want to be active as well as pretty. So in most years they wear little hats, commonly of felt or straw.

Thus our hats are no longer so interesting as they used to be, but they are less bothersome.

How to Select a Becoming Hat

Of course no set of rules can take the place of what we know as "taste" in choosing hats. But there are certain general principles as to what is becoming. First of all, never select a hat that for any reason will make you conspicuous. You will look tawdry in it, no matter how expensive it may be. Next, be careful to choose a hat suited to the purposes you will use it for. That too is a matter of 'good taste.' If your face is small do not crown it with an enormous bulk of straw or felt. and if it is long and thin do not wear a hat with too much height. Of course a broad face should not have too broad a hat. And most faces look much better in a hat that frames them.

Reading Unit No. 1

THE TALE OF A GRAIN OF WHEAT

Note. For basic information not found on this page, consult the general Index, Vol. 15.

For statistical and current facts, consult the Richards Year Book Index.

Interesting Facts Explained

How long has man grown wheat? 9-97

Where wheat grows, 9-98

Spring wheat and winter wheat, 9-98-100

Why farmers are interested in different strains of wheat, 9-100

Plant and animal enemies of wheat, 9-100, 101

How wheat is harvested, threshed and winnowed, 9-101

The history of wheat in the United States, 9-101

Flour and bread from wheat, 9-102

Things to Think About

What countries grow the most wheat?

Why is the common barberry plant uprooted whenever found?

What states of ours grow the most wheat?

Why should our national prosperity be affected by the price of wheat?

Picture Hunt

What parts of the new plant are the first to come out of a growing wheat kernel? 9-99

What country still has old-fashioned means of ploughing? 9-101

Related Material

How was the price of bread brought down? 10-409-13

What goes on in a flour mill? 9-233-36

How is man able to fight wheat rust? 2-140-41

How much wheat do you eat each year? 9-236

How is our bread baked? 9-241-43

Leisure-time Activities

PROJECT NO. 1: Visit a large bakery and learn how bread is made, 9-242.

PROJECT NO. 2: Place some wheat kernels between two sheets of wet blotting paper inside of two saucers. Watch what happens for a week, 9-99.

Summary Statement

Wheat, which is grown almost everywhere, has been known to man for thousands of years. In the past, all the work of planting and harvesting wheat was done by hand. To-day, because machinery does the work, and because growers use selected seeds, more wheat is produced.

The gathering of the wheat harvest has always been one of the most important events in the lives of people all over the world. To the artist, it promises a beautiful painting, rich in color; to the poet, it suggests the wonders of nature and the fulfillment of dreams; to the humble laborers it is the reward for long months of hard work, and means the safeguarding of home, family, and even of life itself.

The TALE *of a* GRAIN *of* WHEAT

And of Many a Billion Other Grains of the Cereal That Men Were Eating with Nearly Every Meal Long before They Ever Thought of Having Tables to Eat On

OF COURSE you have noticed the shape of a grain of wheat, how it tapers gently and has a deep groove down one side of it. You could notice that much even if you had never seen a grain of wheat except puffed for a breakfast food. Now if you have a sound, uncooked grain and a magnifying lens, you may take off the outer covering, or bran, and look at the bottom of the groove to see what you can see. You should be able to find a tiny bit of rootlet and sprout which is called a wheat embryo (ĕm'brĭ-ō) and which would have grown up into a stalk of wheat if you had planted it instead of looking at it so curiously. It would have thrust its growing rootlets into the earth, and sucked the good food out of the wheat grain itself for all the world like a chicken growing inside an egg. Pretty soon the leafy sprout would have thrust upward out of the ground, turned green, spread and grown, making now its own food out of earth and air. In time its top would have grown into spirals of flowers, with no petals but with pistil and stamens ready to produce other grains of wheat.

How long men have been planting wheat and anxiously watching it grow we are not sure. The wild wheat had already been tamed and grown for food at least two thousand years ago in China. In Egypt it must be at least two thousand years older than that, for grains of it have been found buried with kings who have been dead six thousand years. It was buried with some of the primitive Swiss lake dwellers, too, perhaps as long ago as ten thousand years. In other parts of Europe—where, by the way, it is often called corn—it has been known since history began. It came to the United States with the colonists in the seventeenth century, though for a time the white people preferred

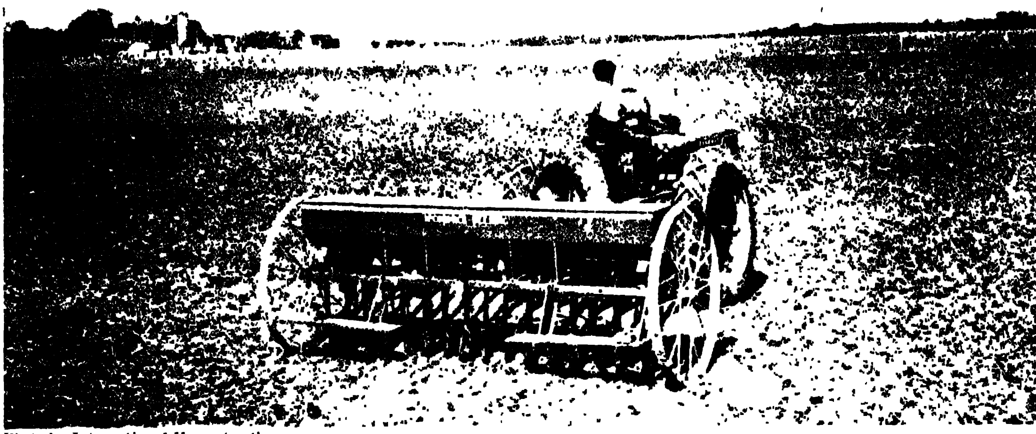


Photo by International Harvester Company

This drill, pulled by a tractor with a boy at the wheel, is planting wheat. With magical skill it will furrow the ground, drop the seed, and cover it up as the wheels go by. Drills also spread lime and fertilizer.

to grow and eat the Indian corn—in Europe called maize. Now fields of wheat wave golden in the sunshine from Abyssinia to Ecuador, from the frozen Arctic to the Argentine. It is perhaps the most important and widely distributed of all cereals.

The World's Great Granaries

Our grain of wheat, then, might be planted in almost any country in the world. Wheat will even grow north of the Arctic Circle in some places. It will grow at sea level or as high in the clouds as ten thousand feet as it does in Abyssinia, Tibet, Ecuador, and Colombia. It will not do very well in damp tropical climates, and most of it is grown in the Northern Hemisphere between latitudes 30° and 60° say as far south as the Gulf of Mexico and as far north as the Bering Sea. The United States produces nearly a quarter of the world's crop, Russia nearly another quarter; Canada comes third, and France fifth. These are all in the Northern Hemisphere, more or less between the latitudes we spoke of. But India produces more wheat than France, though she lies mostly south of 30°, and Australia and the Argentine, in the Southern Hemisphere, are among the greatest wheat-growing countries too.

Wherever it is sown, our grain of wheat will do better if it is allowed to grow in deep, well-drained loam or clay, although it will make shift with almost any kind of soil except dry sand or wet peat. But it cannot be grown year after year in the same soil. Either other crops must be "rotated" with it, or once in a while the land must lie fallow—that is, be left without any crop at all—for a season.

Of course someone has to sow our wheat. For thousands of years this was done always by hand. The farmer loosened the ground with a spade or hoe, or later with a harrow. Then he put his seed grain in a bag or bucket and, guided by stakes to enable him to keep him going straight, he walked up and down the field scattering the seed and he learned to do it quite evenly too. On small farms, or in the mountains or other out-of-the-way places, it is still done in that way. But if our wheat grain is to be sown, say, on one of the vast prairie farms or ranches of Kansas or Montana, it will now be dropped efficiently from a big machine called a drill.

Spring Wheat and Winter Wheat

When our seed wheat is dropped on the field and the good earth turned over it, the birds may be gossiping about the first coming of spring, or the air may already hold the tang of late autumn. For there is spring wheat and there is winter wheat. If the winters where he lives are not too cold, the farmer may prefer the winter kind, for it will start growing in the autumn, lie snug under the snow all winter, and then leap upward in the spring and ripen when the spring wheat is just beginning to flower. In years

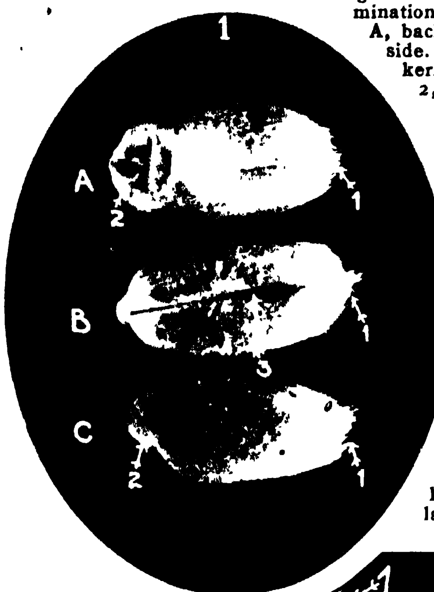


Fig. 1. Wheat kernels before germination (enlarged six times). A, back view; B, front; C, side. The parts of the kernel are: 1, brush; 2, embryo; 3 groove.

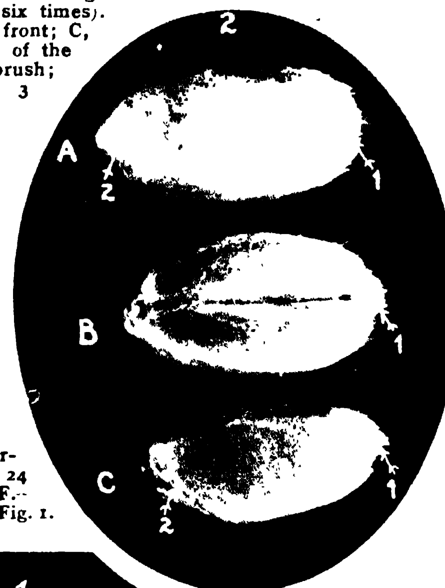


Fig. 2. Wheat kernels germinated for 24 hours at 68° F.—labeled as in Fig. 1.

Fig. 3. Wheat kernels germinated for 48 hours at 68° F. Here the brush and embryo are as in Fig. 1, but the kernels have sent out a plumule and stalk (4), which will become the leaves; and a radicle (5), which will become part of the root system.

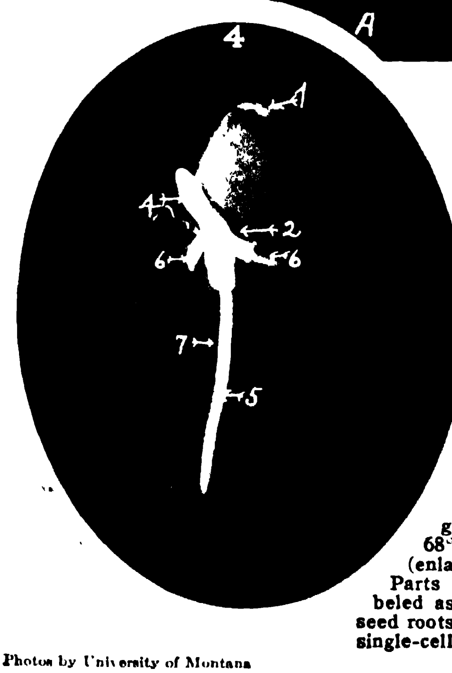


Fig. 4. Wheat kernel germinated at 68° F. for 72 hours (enlarged three times). Parts 1, 2, 4, and 5 are labeled as above; 6, seminal or seed roots; 7, root hairs, which are single-celled absorbing organs.

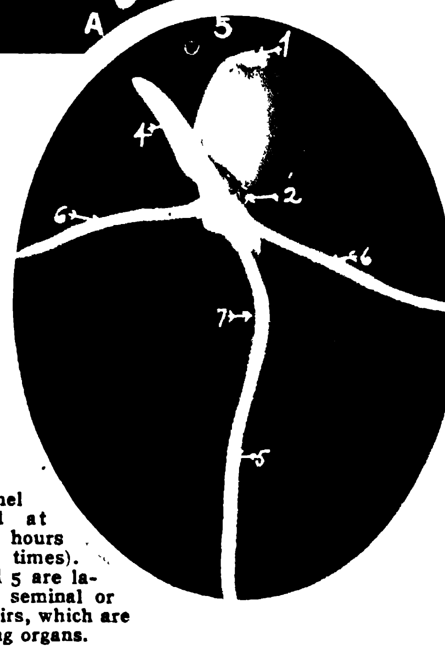


Fig. 5. Wheat kernel germinated 96 hours at 68° F. (enlarged three times); the parts of the kernel and young plant are labeled as in Fig. 4. All this has happened to our grain of wheat in only four days' time!

Photos by University of Montana

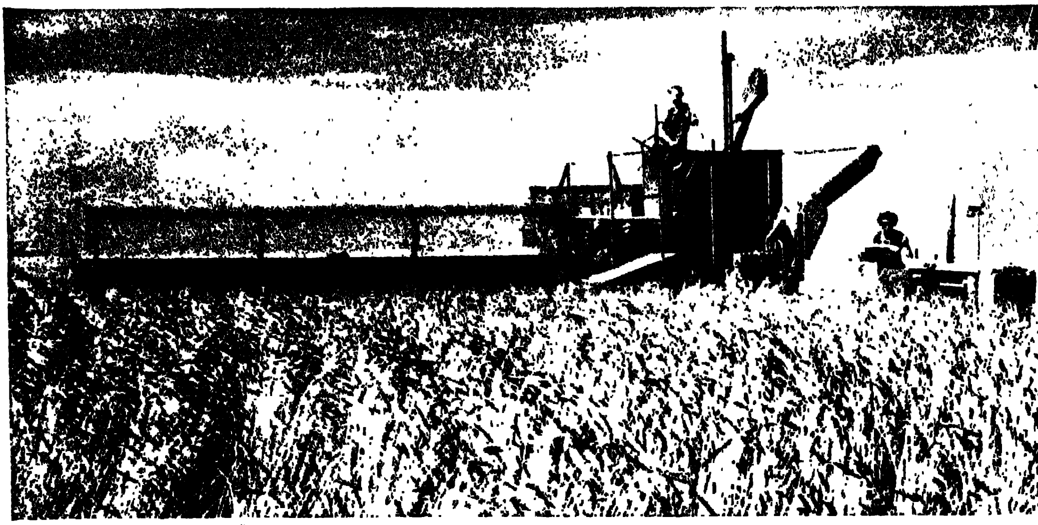


Photo by Caterpillar Tractor Co.

If the ancient Egyptians were to see this harvesting machine, they would probably imagine that it was some strange monster with a mind and the ability to think, for it does its work with such precision and efficiency that it seems almost to know and plan what it is about. The tractor and apparatus you see above can cut and thrash the wheat all at the same time which of course saves a great deal of labor.

of mild winters, winter wheat will do well as far north as South Dakota; in cold years it may fail as far south as Kansas. Over twice as much winter wheat as spring wheat is grown in the United States.

A Wheat for Every Climate and Soil

The time of sowing is not the only difference between varieties of wheat. Some kinds of wheat have hard grains, some soft. Some are yellow, some red, some white. Some are bearded, some are not. There are differences in the shape of the leaves, the size of the head, and the time of ripening, in hardness and in fitness for certain climates. Growers are always selecting seed and crossing varieties to see if they can get something that has all the qualities they want and none of those they dislike. In fact, the United States Department of Agriculture has imported for experimental purposes not less than 3,500 different kinds of wheat. Kharkof and Kanred come from Russia; marquis is a new kind developed in Canada; durum, Scotch fife, bluestem, red northern, and early baart are other kinds popular in Canada and the United States. The kind the farmer grows depends largely on the climate and on the amount of moisture in the soil.

Of whatever variety it is, we are to imagine our wheat plant now waving green in the sunshine. It will not need to be trimmed and sprayed like a fruit tree or weeded like potatoes or onions. But it has plenty of enemies for all that. If it is winter wheat, it has already run the risk of dying during the winter if there has not been enough snow to blanket it from the cold and anchor it safe from sweeping winds. Now, no matter when it was sown, it must take the weather as it comes through the spring and summer. Many a wheat grower has stood by groaning helplessly while hot winds blighted his crop or droughts seared it or great hailstorms beat it to the ground. Squirrels and rabbits and prairie dogs may burrow into its roots. Insect pests may attack it—chinch bugs or army worms or the dreaded Hessian fly.

The Ills of a Wheat Field

Then there are the fungus diseases—stinking smut, loose smut, stem rust, leaf rust, seedling blight, scab, and foot rots. The rust is the most dreaded of all. The rust fungus, which is a tiny plant growth, attacks the wheat and destroys its ability to make food from the air and sunshine. The leaves turn brown or black, like rusty tin, and the plant cannot produce any seed. Luckily for us all, this little parasite—a parasite (păr′ȧ-sīt) is a

plant or animal which lives on another—does not live on wheat all the time; that is to say, only every other generation of it lives on wheat. The off generation lives on barberry plants, whose leaves it destroys while it is waiting for the next crop of wheat to grow up. Of course what wheat growers do, now that they have discovered this odd fact, is to root out all the barberry and so starve the rust fungus out. The plan does not always work, but it usually succeeds.

At last our wheat plant has weathered all dangers and is ready to be harvested. If it is spring wheat it has been growing about four months, and the time of year now will be anywhere from May to September according to where we are between the southern part of the United States and the northern part of British Columbia And what a sight the harvest is, nodding and dancing in golden wave on golden wave as the wind steps over the broad acres which stretch, perhaps, to the far horizon! It must none of it be wasted. We will be sure to cut it at exactly the right moment, just before the wheat is dead ripe. For overripe wheat threshes so easily that many seeds are shaken out and lost in gathering it.

Some people are not fortunate enough to have machines to help them do their work. In Italy you may see many an ox team like the one above, ploughing the fields for the wheat crop. Many lovers of Italy will be sorry when the place of these picturesque animals is taken by noisy machinery.

How Wheat Is Cut, Threshed, and Winnowed

There are old ways and new ways of harvesting the wheat, as there are of sowing it. It must be cut and threshed and winnowed - that is, the plant must be cut from the roots and gathered; the grain or seed must be loosened from the rest of the plant; and the seedless stem, or "straw," and the light particles of waste, or "chaff," must be removed, leaving the clean grain. For thousands of years grain was cut by hand with a curved knife, such as a sickle or scythe. Then it was threshed by being thrown on a hard surface and beaten with a hand implement called a flail, and winnowed by being dropped from a height when the wind was blowing. But, as you know, it nowadays is a poor or out-of-the-way farm that cannot at least hire a machine harvester and a machine thresher to do the work. Some machines cut and thresh and winnow all in one operation.

It was the perfecting of the great machines for sowing and harvesting which conquered the wide plains of the American "Inland Empire" for wheat. The first American wheat belt was from Delaware and Maryland to central New York, and the second was the Ohio Valley; much wheat is still grown in both these regions. But shortly after the Civil War settlers began to pour into the Western plains, and soon the best wheat states were west of the Mississippi: Montana, Washington, the Dakotas, Nebraska, Kansas, Oklahoma, with Kansas the most productive of them all. This is good wheat country level and easy to cultivate, temperate in climate, spacious But at that it does not yield nearly so much to the acre as much European wheat land, the average yield is only about sixteen bushels against thirty or forty for certain parts of Europe. But that is where the great machines come in. On the plains, with the help of the machines, one man's time and labor goes much farther than it can on a small or hilly farm where machines cannot be used. So the plainsmen make more money after all.

Suppose, then, that our wheat plant grew somewhere on the great American plains. We have it separated now into two parts the straw and the grains of wheat. The straw will not be wasted. It can be made into many things--paper, hats, mats, baskets, mattresses, artificial flowers. On small farms where live stock is kept, it is used for

stable bedding or converted into manure to be returned to the fields as fertilizer. Or it may have been left in the field when the crop was harvested, as will have happened if our farmer used a combination reaper and thresher, or if he cut his grain with a "header," which merely snips off the tops of the plants and leaves the rest standing as before. Then it will simply be turned under with a plow to enrich the ground—in order to grow more wheat!

As for the grain itself, it is only starting on its adventures. Some of it will be saved for seed wheat, as the kernel we started out with must have been. Some will never travel far from its native ranch. But much of it will be shipped direct to market, or stored in great storage buildings called elevators until the owner thinks it will bring a better price. Then out to all the world it goes, to be sold and ground into flour and made into cakes and pastries and pies and, above all, into bread for you and me.

The larger part of the wheat grown in the United States is sold and eaten in the United States itself. Most of the rest is exported. If our wheat was grown in the northern part of the wheat belt, it will probably set out on its travels by heading for Minneapolis, Duluth, Chicago, St. Louis, or Milwaukee. From there it may go East to furnish the toast on almost anybody's breakfast table. Or it may not stop in the East but take passage on a freighter for England or Central or South America. If our wheat was grown a bit farther south, it may go by way of Kansas City for the home trade or of Galveston for export. Or, especially if it was grown farther west, it may find itself in Portland, Oregon, perhaps about to strike out for the Orient. Today Canada exports far more wheat than any other country in the world, with Argentina following.

Wherever wheat goes, it will probably at some time or other be ground into flour. And thereon hangs another tale. For not all kinds of wheat have the same value as food. The value depends on what is in the grain. If our wheat belongs to a hard variety, such as durum, it has in it a good deal of the substance called gluten, and will make light, spongy bread. If it is soft wheat, on the other hand, there will be less gluten and more starch, and it will have to be mixed with some hard variety to make good flour. Spring wheats usually have more gluten (glōō′tĕn) than winter wheats.

The reason that gluten is so valuable is that it is a sticky substance and holds the gas produced by the yeast or soda or baking powder put in the dough to raise it. If this gas escapes, as it will if the flour has too little gluten, the dough will fall. And who wants soggy bread or heavy pastries or the stomach aches that eating them would bring? To be sure, some kinds of dough do not require so much gluten as others. Macaroni takes about the most, and is made only out of the hardest wheat, such as the durum raised in countries around the Mediterranean Sea.

We eat a great deal of bread. We eat a great deal of cakes and pies and pastries too, but in particular we eat bread. It is one of the most satisfying and wholesome of foods, and most of us eat it at every meal. The amount of wheat flour which Americans ate per person went up steadily all through the nineteenth century—keeping pace with the planting and reaping of more and still more acres of wheat. It is said that we do not eat quite so much now, perhaps because we have learned to vary our diet more. But as it is, the wheat crop of the United States alone is worth well over a billion and a half dollars annually. Of late years much of our white wheat flour has been enriched with vitamins, especially with B_1. This gives it the same food value as whole wheat flour, which formerly was the more nutritious.

A harvest field in which horses still play a part.

Reading Unit No. 2

THE GOLDEN GRAINS OF INDIAN CORN

Note: For basic information not found on this page, consult the general Index, Vol. 15.

For statistical and current facts, consult the Richards Year Book Index.

Interesting Facts Explained

Things to Think About

Of what value was the practice of planting corn seeds together with a fish?
What is the chief use to which we put our corn?
In what forms is corn eaten by man?
How many kinds of corn have we?
Do you think we should eat more corn and less wheat?
Should farmers grow hybrid corn?

Picture Hunt

What is meant by corn on the cob? 9–104
How can a farmer cultivate so many acres of corn in one day? 9–105
What has made the harvesting of corn a simple operation? 9–105
What should you say to be the average number of kernels on an ear of field corn? 9–104

Related Material

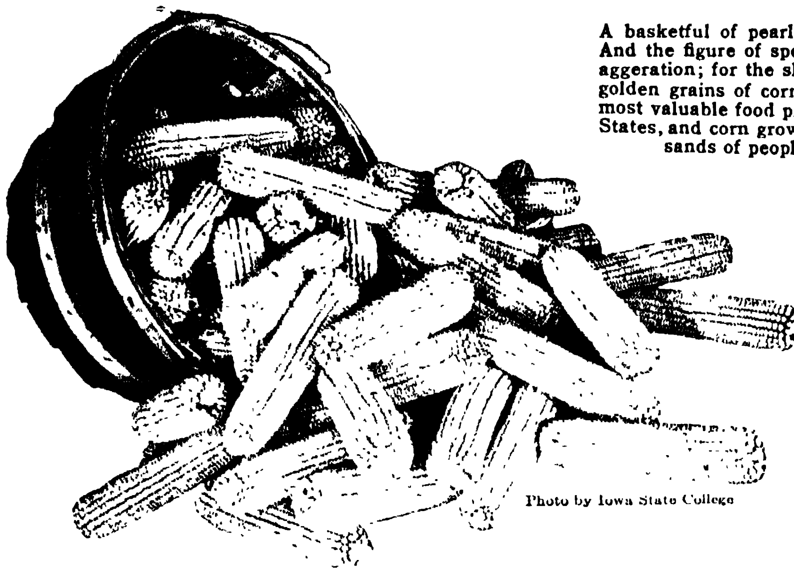
Why do the kernels of corn on the cob often look as if they had been chewed? 2–137
What do we find inside a corn stem? 2–31
How did Luther Burbank improve plants? 13–417
How did American Indians make their bread? 9–239, 13–476
What would you never have found on Julius Caesar's table? 9–142

Leisure-time Activities

PROJECT NO. 1: Get popcorn and a popper and pop some corn on your stove, 14–83.
PROJECT NO. 2: Plant some corn kernels in your garden early in May.
PROJECT NO. 3: Learn how to roast corn for camping, 14–553.

Summary Statement

The greatest gift given to civilization by the American Indian was Indian corn, which must be raised from seed each year. Corn is eaten by man and beast, and the corncobs are made into plastic. Much of the corn raised is used to fatten hogs for the market. Sirups, starch, oil, and sugar are important corn products.



A basketful of pearls and golden beads! And the figure of speech is hardly an exaggeration; for the shimmering white and golden grains of corn are now one of the most valuable food products of the United States, and corn growing gives many thousands of people a livelihood.

Photo by Iowa State College

The GOLDEN GRAINS *of* INDIAN CORN

Most of the People in Europe Think Corn Is Fit Only for Horses to Eat, but That is One Thing about Which Americans Know Better

THREE or four seeds and a nice dead fish! That was what the Indians put into every hill of corn--and glad enough the white people were to learn how they did it. For European grain was scarce in the early days of the colonies, and all the seed had to be brought from far across the sea. It seemed most providential to find this good new grain that the Indians had been raising so long.

No one could say just where they had found it. It does not grow wild to-day. But it probably originated somewhere in the American Tropics, and from there was gradually carried north by the red men till it spread over all those parts of the land where the seasons were not too short. For corn will not grow in the more northerly latitudes. It flourishes best in the Mississippi Valley, and there, in what is known as the Corn Belt, the bulk of our crop is produced. The United States raises some billions of bushels a year, a large part of the world crop. It is raised in every country on the globe.

Of course it grows best where the sun is warm. India grows it extensively, as does South Africa. But in every other land it is known as maize, or "Indian corn." For each country has the habit of referring to its own principal grain crop as "corn." So in England wheat is "corn", in some countries rye is so called, and in others barley, while in Scotland it is oats. But taken the world around, Indian corn ranks next in importance to wheat, and almost as much of it is raised.

Every part of the corn plant is useful. When they are green or properly cured, the stalks and leaves make good fodder. Dried, they can be used in manufacturing paper and rayon. The cobs are made into plastics. And the rich grain is a valuable food for man and beast. It is the best thing there is for fattening cattle and hogs, and a large part of the crop is used for this purpose. Altogether corn is put to several hundred uses in industry and as food.

And plenty of it comes to our tables. In the form of meal it is made into "hasty

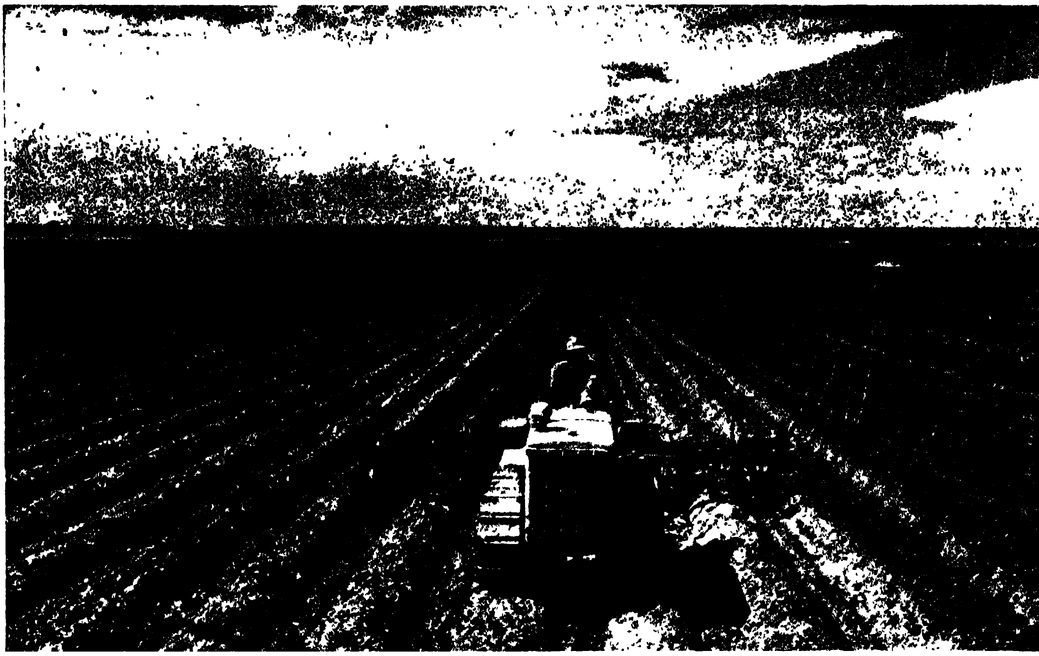


Photo by Caterpillar Tractor Company

As the tractor drags our cultivator along the furrows in this field on the high plains of Colorado, five rows of young corn will be cultivated. That means that weeds will be uprooted and the soil stirred in order that it may hold in moisture and be loose enough to let the young roots grow. If need be, a dressing of fertilizer will be added, also. As the plants grow larger, teeth of different sizes and shapes will be used on the machine, for many farm implements have a variety of interchangeable parts. With a device of this kind one man can cultivate seventy acres of corn in a day—nearly nine times as much as in the good old days.

Photo by International Harvester Company

Many a backache and a tidy sum of money will be saved by this corn picker, which not only cuts the corn but picks and husks it as well. It can clean up twenty acres of high-yielding corn in a day. Of course a machine like this one is very complicated and therefore too expensive to pay on a single small farm—since, like many other farm machines, it will be used only for a day or two in the whole year. For this reason farmers often band together in a cooperative association in order to buy their machinery.

puddings" and the nourishing mush of our childhood, or into johnnycake and the famous "corn pone" of the South. It goes into the hoecake of the Negroes - a simple mixture of corn meal, water, and salt, which takes its name from the artless utensil on which it first was baked. Then, too, we eat green corn on the cob, and dried corn in the form of hominy; or we put the whole grains of a special variety over the fire till they burst into the delicate white puffs that we know as pop corn. But nourishing as corn may be, we cannot bake it into fine-grained bread of the kind that we make from wheat or rye.

Besides the meal into which corn can be ground, the grain yields a number of other valuable products. Corn oil, corn sirup, corn sugar, cornstarch, and a substance called dextrin, bring in a handsome total to the manufacturers every year. Corn is made into alcohol, and helps in the manufacture of some valuable medicines, such as vitamins, penicillin (pĕn'ĭ-sĭl'ĭn), and sulfa drugs.

Three Hundred Kinds of Corn

Altogether there are more than three hundred varieties of this valuable grass, and they differ from one another amazingly in shape and size. Some are only a few inches tall, and others grow as high as ten feet. Some are white in grain, some yellow, some purple, and some striped. Some ripen in two months, while others take as much as seven.

In general the corn raised in this country may be divided into three great classes: field corn, sweet corn, and pop corn. Dent and flint are the principal varieties of field corn, the second being raised in the northern part of the country, where dent corn will not mature. Sweet corn is of course raised largely as a garden vegetable, and eaten from the cob while it is still green—though of late a great industry has sprung up in the canning of the tender kernels. Pop corn is a smaller variety than the other two, and usually the kernel has a sharp point at one end. It pops because moisture imprisoned in it turns to steam under heat and bursts the grain. It is very nutritious.

Of late years there has been a revolution in corn growing. It comes from the discovery (1905) of a way to breed seed corn by crossing various desirable strains to get a variety that will be uniform in height and grow its ears all on the same level. Such corn can be picked and husked by machine at the rate of a thousand bushels a day, with two inexperienced boys to run the machine. This means a great saving, for with ordinary corn a hundred bushels a day is about all even an expert worker can manage. But still more important, the new "hybrid" or cross-bred corn will yield some twenty-five bushels more per acre. That means a good deal more money for the farmer and a good deal more food for a hungry world to eat. Besides, hybrid corn can be bred for a variety of purposes. Some of it has twice as much protein as old-style corn. Other strains have three times as much oil, or perhaps more of those elements used in making penicillin.

How Hybrid Seed Corn Is Grown

It is true that hybrid seed corn is expensive, and it must be bought fresh every spring. For hybrid corn reverts to the original strains if you plant seed from it. So a handful of producers grow it for the farmers who plant it. To produce it the grower must first produce a pure strain by tying a little bag over every tassel to collect the pollen. Then the pollen is emptied by hand over the silk on shoots on the same plant. This must be done for seven successive years. Then two different strains are crossed by sprinkling the pollen from one strain over the silk on another strain. This takes three years. At last two crosses of this kind are crossed to give the final hybrid seed -which even then may not yield a desirable variety. The investment in time and labor has reached a staggering total, but in the end it pays both the producer and the farmer who plants the seed. Some states grow almost no other corn.

Our corn brings us between two and three billion dollars a year and is our most valuable crop. Much of it is raised in Iowa, but the whole Middle West grows it in vast amounts, for more than any other region it has the loose rich loam and warm summers that corn must have to thrive.

Reading Unit
No. 3

A GRASS THAT FEEDS A THIRD OF THE WORLD

Note. For basic information not found on this page, consult the general Index, Vol. 15

For statistical and current facts, consult the Richards Year Book Index

Interesting Facts Explained

Things to Think About

Why are rice fields purposely flooded?
Why does a diet of rice alone cause death from starvation?
Why is rice an important food in China?
Are the rice-eating peoples as vigorous as those who eat other cereals?

Picture Hunt

Related Material

Leisure-time Activities

PROJECT NO. 1: Get some brown rice at a grocer's, and cook and eat it. Compare its flavor with that of polished rice.

PROJECT NO. 2: To learn whether starch is present in rice, add a few drops of iodine to some cooked rice. A blue-black color shows that starch is present.

Summary Statement

Rice supports millions of people. Most of it is grown in the Orient in fields which are flooded. The water is drained off to let the grain ripen in the sun. Unpolished brown rice contains the valuable vitamins and mineral salts so important to health.

of Natural History

Men ate rice long before they learned how to cultivate it. Here Indians are shown gathering it wild along the shallow margin of a lake or river in North America. And long before the Indians came, the wild ducks, we may be sure, had learned where to find those toothsome grains—and how to gather them!

A GRASS THAT FEEDS *a* THIRD *of the* WORLD

Grown under the Water, Rice Is Always the Main Thing, and Often the Only Thing, That 600,000,000 People Have to Eat

THE first rice that ever grew was merely wild grass. In that form it was growing in India, and also in Australia, long before men ever found out that its seed was good to eat. When they learned how good it was—and that too was long ago—they began to cultivate the grass, and slowly to improve it. In India and China they were cultivating it long before history began, and at least twenty-four hundred years ago they had brought it as far west as the banks of the Euphrates.

The plant came into Spain with the Arabs, and slowly spread into the other parts of Europe which were warm enough for it to thrive. In 1674 it was brought over to Virginia, but it did not do well in its new home. Twenty years later it began to thrive in South Carolina, and since that time it has been an important crop in some of the southern states. It is now grown mostly in Louisiana, Texas, Arkansas, and California, though of course the vast crops of the plant still flourish in the Far East—especially in India, China, and Japan.

In all these travels and under all this cultivation, the simple grass that we call rice has come to have a great many varieties. The rice that comes to our tables may all look about the same, but the plants that gave it to us may have been very different in appearance and in their ways of growing. They are always "annuals"—that is, they all spring from the seed of the plant, and not from the root in the ground. But they may grow up and ripen in as little as three months, or they may take as much as six; and they may grow under water on some rich river bank—the natural home of rice—or they may have been planted fairly high

up on some mountain side. So what we are now going to say about a typical rice crop is not wholly true of every crop of rice in the world. It will be true only of most of the great rice crops in the Far East.

First the seeds are scattered by hand over the field, in the same way that wheat used to be sown by our farmers, and is still sown on many a small farm. Then the field is flooded, for the plants sprout and grow best in shallow water. In three or four weeks they are taken up and planted again in another place, called the "paddy" field. Here they are still under the water, though they are now set out in rows in order that they may be cultivated as they grow.

The main job of the cultivator is to keep down the weeds, and anyone who has ever weeded an ordinary garden will know what a task this must be in the moist, rich soil that rice requires. In the East the whole family—men, women, and children—will be in the rice field pulling up the weeds all the long day. Since they can hardly kneel down in the watery ground, they save themselves many a backache by learning to be as expert with their toes as we are with our fingers. They pull up the weeds with their feet. Sometimes the water may be drained out of the rice field on the weeding days, but if so it is pumped in again as soon as the weeding is done.

In the broiling sun these patient Japanese laborers are pulling up young plants that were sowed here some three or four weeks ago and are now ready for transplanting. The whole family turns out to work in the muddy field, which must often look like some strange lily pond, when grandmother and the girls put up their bright Japanese umbrellas to keep off the sun.

Above, a "paddy field" in India is being prepared to receive the tender young plants that have been sown elsewhere. Of course the soft mud that these water buffaloes are plowing will be flooded later.

Photos by Indian Sta Ry., Field Museum al Education Servic

These people live in Sumatra, another land where rice flourishes under the hot sun. They are busy transplanting the young shoots that have got a good start in another field.

In the East there are no machines such as we know for pumping water. The pumping is all done by straining muscles, usually of men, though sometimes of some trained animal such as a water buffalo. It is hard work. Hour after hour a man perched on a big wheel above some water-course will keep turning the wheel with his feet, and with its cups or scoops the wheel will keep lifting the water to spill over the field until the crop is flooded. A little wheel may be only six or eight feet high, but a big one may look a bit like a small Ferris wheel in one of our amusement parks.

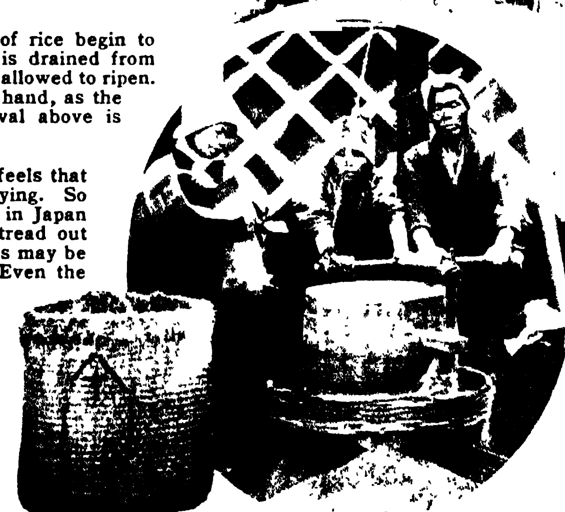
The work is done most easily when the

Below: Stacks of newly harvested rice in Java.

As soon as the leaves of rice begin to turn yellow, the water is drained from the field and the grain is allowed to ripen. Then it is cut, often by hand, as the Javanese girl in the oval above is cutting it.

In the Far East no one feels that he must be always hurrying. So the rice crop is threshed in Japan by men, or oxen, who tread out the grains; or the kernels may be combed out by hand. Even the straw is used for hats and sandals and bags.

The heat makes this Javanese girl glad to work in the water.



Above: Husking rice in Japan.

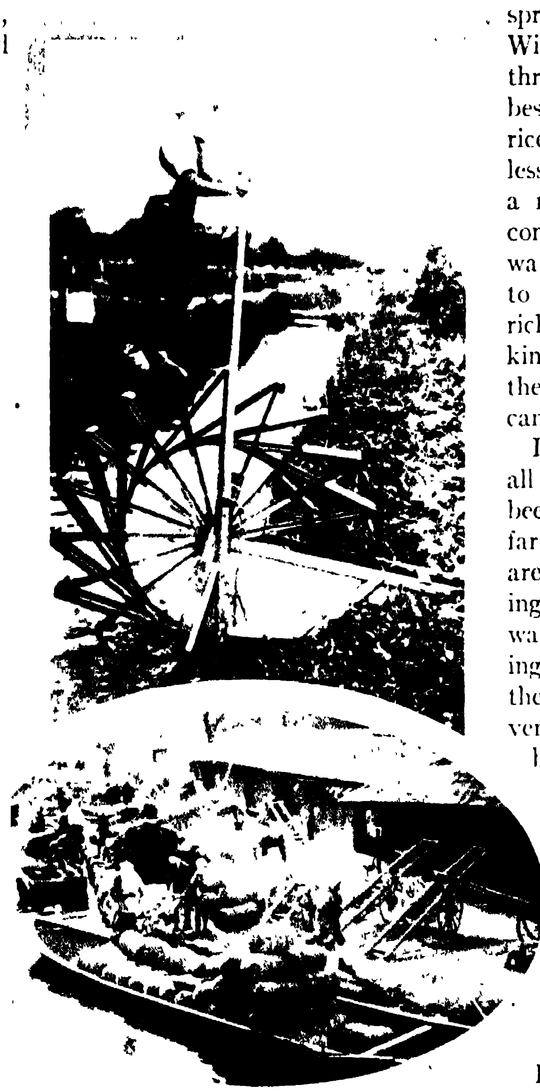
Below: Separating rice grains from chaff in the Philippines.

Photos by Field Museum, American Museum of Natural History, and Bureau of Agriculture, P. I.

rice field is right beside a river or canal. But a great deal of rice is grown on hillsides or mountain slopes, and then the fields have to be laid out in terraces, one below another, and flooded one after ai with such water found up on the s

When the leav the rice plant beg turn yellow, it is ti drain off the wate let the crop ripen sun Then the are harvested witl fashioned sickles, the grains of ric threshed out by drawn through th teeth of a primitiv chine. They are n shiny white grain we know in the They wear a little l coat, and in the this coat is neve ished away. It is much better to le the coat on, for a good deal of the food in the rice especially the vitamins and the mineral salts comes only in the coat A man who had to live on rice alone, as many people in China and Japan do, would soon sicken and die if he scraped off the brown coat before eating it. In the West we peel off the coat to make the rice look prettier, but we lose a good deal in food by doing so.

As soon as one crop is harvested another will be planted. The rice field seldom gets any rest. In Southern China and in other warm lands there may be four crops from one field in a single year.



tos by American Mus
nd Presse-Photo Berli

All day long the Japanese farmer in the upper picture must tread that strange contrivance for irrigating his rice field. He turns a wheel provided with little cups that lift the water out of the ditch. In the oval, rice is being loaded on boats in China, ready to drift down the long Chinese rivers to the port for shipment all over the world.

What a rice plant loves is plenty of warmth, plenty of water, and plenty of the rich soil that the rivers bring down and spread over their banks. With enough of these three things it does its best. When a man wants rice to grow in a place less moist and rich than a river bank, he must contrive to bring the water and the rich soil to it. So he then enriches the soil with some kind of fertilizer, or with the mud scraped out of canals and streams.

In the West, of course, all the work we have been describing is done far more easily. There are machines for ploughing, for sowing, and for watering, as for harvesting and threshing. But the West does not loom very large in the rice business. To be sure, the United States produces a good many millions of bushels a year, but China grows vastly more than the United States. And the Eastern countries together produce more than 95 per cent of the rice of the world. That is why we have been telling how it is grown in the place where it is of vast importance.

In the East rice is the one main thing to eat. Whatever else a Chinese may have on his table, he will always have rice. Unless he is a rich man, and rich men are scarce in China, he will hardly have anything else. So it is the main food of six hundred million people.

Reading Unit No. 4

THE GRASS THAT GIVES US SUGAR

Note: For basic information not found on this page, consult the general Index, Vol. 15.

For statistical and current facts, consult the Richards Year Book Index.

Interesting Facts Explained

How people obtained their sugar long ago, 9–113
How natives extracted sugar from sugar cane, 9–114
How sugar is extracted from sugar cane to-day, 9–114-16
Why very little sugar cane is raised in the United States, 9–116
Sugar from beets, 9–116

Things to Think About

How do plantations make sure they will have enough sugar cane the following year?
How are the waste materials of sugar canes used?
How is raw sugar purified?
In what form is sugar sent to the refineries?
Do you believe that modern man is better off because he eats more sugar than ancient man did?

Picture Hunt

In what way is the harvesting of sugar cane old-fashioned? 9–113
Why must sugar juice be heated? 9–114
What kind of a plant is sugar cane? 9–115
How are tiny blocks of sugar made? 9–116

Related Material

Does all our table sugar come from sugar cane? 9–126-27
How has sugar affected Hawaiian politics? 8–460
How do leaves make sugar? 2–41-44
How is maple sugar obtained? 9–122-24

Leisure-time Activities

PROJECT NO. 1: Ask your vegetable dealer to get some sugar cane from the commission market. Suck the sweet liquid. 9–115.

PROJECT NO. 2: Cover a leaf on the geranium plant with carbon paper and place the potted plant in the sunlight for a day. Crush the leaf that was covered and boil it in Benedict's solution. Crush an uncovered leaf and boil it also in Benedict's solution. If a brick-red color results, it shows that sugar is present. When do plants make sugar?

Summary Statement

Sugar cane is a tall grass which stores most of its sugar in the stalk. The stalk is cut up and the sweet juices squeezed out. The liquid is then evaporated under a vacuum until the sugar is solid. Bleaching makes the sugar white.

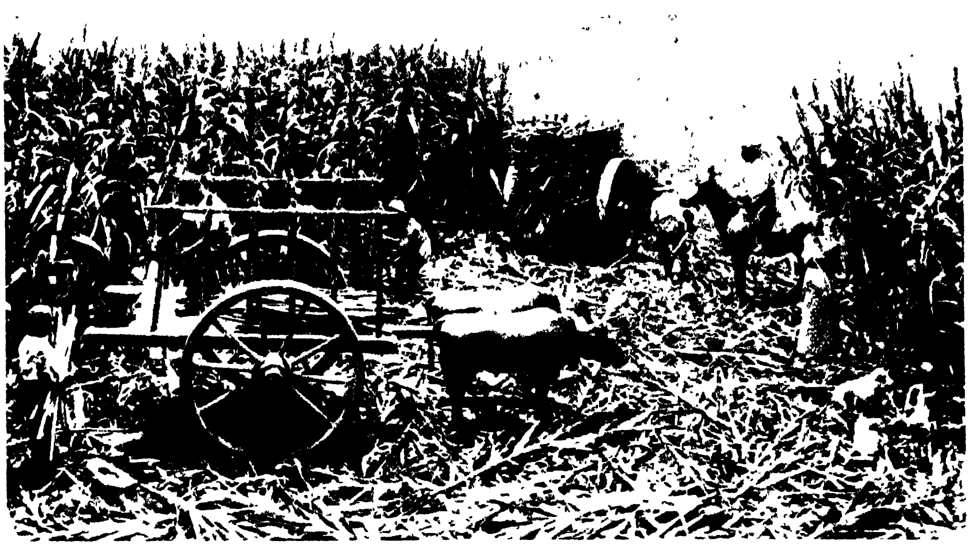


Photo Copyright by Milwaukee Public Museu

In spite of all man's labor-saving inventions, the harvesting of the sugar cane in tropical countries is often carried on in a very picturesque and leisurely fashion. Native workers are usually slow, and certainly oxen were never noted for speed! But eventually these carts will reach the machines, and there the stiff cane will be made to give up its sugary juice to sweeten the food and drink of the world.

The GRASS THAT GIVES US SUGAR

Boys and Girls Chewing the Sweet Stems of a Tropical Grass Taught the World Where to Find One of Its Most Important Articles of Food

IF YOU had traveled to India in the days of Julius Caesar, you would probably have found children chewing sugar cane--just as they do to-day all over the tropical world, where the sugar cane is cheapest of all candies. But in spite of its ancient lineage, sugar as we know it to-day-in fine white crystals or powder- was almost unknown even as late as the days of Shakespeare. And up to 1840 it was so expensive that only the rich could afford it. The history of its rise to fame is an interesting one. If you had lived a hundred years ago you would have had a piece of candy only very rarely, and perhaps not at all; but to-day each one of us in America eats about a hundred pounds of sugar every year, and the world's normal output is some 35,000,000 tons

It is really all a story of the sweet juice of one plant, the sugar cane. For centuries the only sugar extractors were the boys and girls who chewed its tough stems. But machines and chemistry have changed the chewing of a sweet grass into one of the world's most important industries. This all began when coffee, tea, and chocolate became common drinks for everyday people; and that was long after the day of the fashionable "coffee-houses" and "chocolate shops" of England and France in the eighteenth century. They were not much more than rich men's clubs, but they made it plain to the world that

something would certainly have to be found to sweeten coffee and chocolate. Then it was that the sugar cane came into its own.

Since this tall grass was already well known, it was natural that Europeans should

Before modern machines were widely used this was the only method of sugar making. It is used in some remote places even to-day. To the left you see the primitive mill in which the cane is pressed; the juice flows into a barrel. Below is the old-fashioned way of boiling down the juice to crystallize it into sugar.

Photos by American Museum of Natural History

urn to it in their search for some kind of sweetener. It had always been grown on a small scale in India and in other regions near its first home in the forests of tropical Asia. There the natives had invented a way to squeeze out the juice under crude rollers operated by men and oxen; you may still see the contrivance at work in rural India and Brazil. From this juice a crude sort of sugar was made. But such sugar was yellow and full of molasses; and since it could not be shipped, the making of it was, and still is, a local industry for simple tropical people.

The Grass We Call Sugar Cane

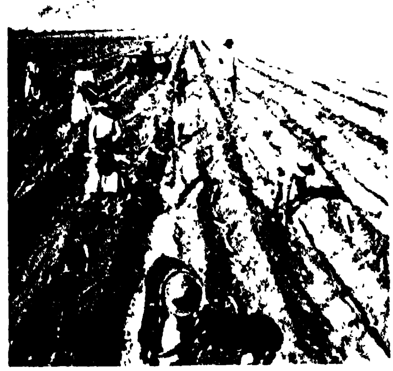
The plant we know as sugar cane is unlike most grasses in that it has a solid, almost woody stem. This grows to be from eight to fifteen feet high, and is crowned by a bunch of leaves that look very much like ordinary corn leaves. It grows naturally in hot, moist regions, and takes only about a year to develop. Then the tough stems are cut off at the level of the ground, and all the leaves are trimmed away. Since these leaves are left on the ground to enrich the soil, they become the cause of one of the greatest dangers to a sugar plantation. This is the danger of fire. The leaves contain considerable sugar, and as they dry they become almost as inflammable as kerosene. A stray match or cigarette stub can easily start a terrible fire, and on many plantations the fields are lighted and patrolled at night to guard against just this danger.

When the tough, jointed stems have been gathered, they are hauled to the sugar mill, which is always near the fields, since the cut canes cannot be kept for long without spoiling. There is a machine for cutting the cane into small sections, each of which, if planted, will produce a new cane within a year. Some of the canes are cut in this way and planted, but most of them are put through the machines that will turn the sweet stem into sugar.

The first machines are really only immense rollers that shred and then crush the cane with a pressure so terrific that it is squeezed to a pulp, known as "bagasse" (bá'gás'). This great pressure squeezes out most of the

The tall, reedy stalks growing at the left of this cultivator yield the juice from which sugar will be made. The field shown here is in Florida, where a certain amount of sugar cane is raised.

sweet juice, but never can squeeze it all out. So bagasse still contains some sugar, in spite of chemical treatment to remove it. In fact, the spent bagasse is so rich in sugary juice that it will burn as fiercely as a cane field. Tons of it were once burned under the boilers of the sugar mill, which had no other fuel. Now bagasse is also used as a cattle food and to make "paper board."

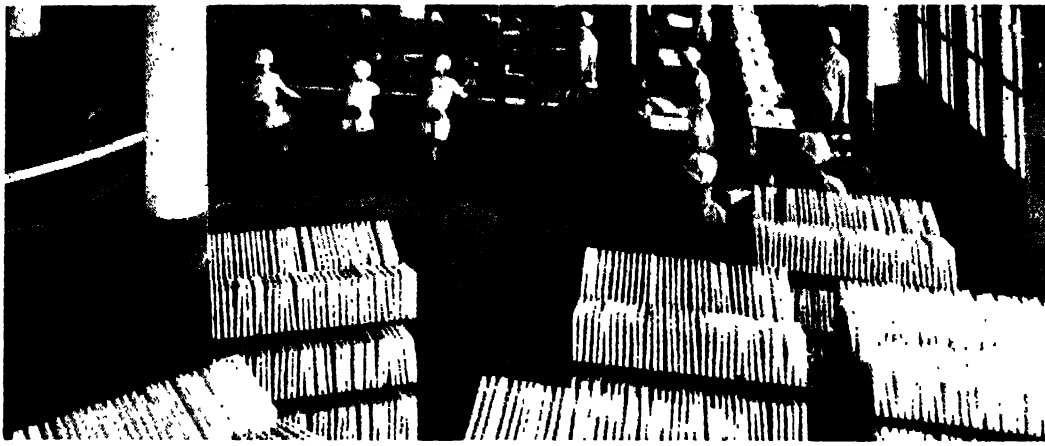


of Natural History

Not all the sugar cane is used for making sugar. Some is saved for planting, which you see in the picture above. The cane that is to become a new crop the following year is cut by machine into short lengths, each of which grows into a tall, slender reed.

The squeezed-out juice of the cane is carried away from the crushers into immense tanks. It contains many other things besides sugar, and at this stage is really only a watery, sweet sap. To remove the impurities it is treated with various chemicals, mostly lime, sulphur dioxide (dī-ŏk′sīd), and carbon dioxide, the effects of which are to clear the sugar juice of most of its impurities. But it still contains a great deal of water, and does not look in the least like the sugar we buy at the grocer's.

The easiest way to get rid of the water is to boil it off. But the sugary juice will not stand much heat; it must not be raised above a temperature that is far below the ordinary boiling point of such a juice. Yet the water has to be removed. By experiment the chemists soon found that under a vacuum the juice could be made to boil at a much lower temperature. So in all modern sugar factories there is a series of high vacuum tanks all linked up into one big evaporating system, and thus the water is



Courtesy American Sugar Refining Co.

To make lump sugar the sirup is poured into flat molds and comes out in great "plates" like those in the foreground above. These are stacked on racks, wheeled to ovens to be dried, and then are cut into small tablets in the machine shown above. A conveyor carries them to the tables where girls are packing them.

boiled away without raising the juice to too high a temperature.

After most of the water has been driven off there remains a substance which the sugar grinders call "mother liquid." This is a rich, sirupy fluid, from which the "raw" sugar, in the form of brown crystals, will be derived. To make this mother liquid give up its crystals of sugar, it is whirled in heated drums revolving at such a tremendous speed that the crystals of "raw" sugar are forced out at one exit, while the residue, which is nearly pure molasses, goes out at another.

The raw, or "brown," sugar, as we call it, is then put up in bags for shipment; and hundreds of ships are needed to carry it from the tropics to the sugar refineries of the world, where it still has many stages to go through before it becomes the ordinary white sugar we use on the table.

When the raw sugar arrives in a temperate climate some molasses still clings to its crystals– that is why it is brown. So the whole mass of raw sugar is first thoroughly washed or dissolved in pure water, and then given another washing in hot water and in certain chemicals in order to remove all its last impurities.

There is then left a very clean white sirup. This is boiled and crystallized much as the raw sugar was crystallized. But the crystals are white and glistening by this time, exactly as you will find them at the store, they are very nearly one hundred per cent pure. Of course all this is done on an immense scale The tanks, pumps, drums, evaporators, and other machinery handle many tons of sugar every day Special machines grind the crystals to make powdered sugar Others will fill bags with sugar and sew them up or will mold the sugar into slabs, cut it in lumps, and pack and seal it in boxes. A whole army of boys chewing cane could not extract the sugar so fast as the machines do

Very little sugar cane is grown in the United States Louisiana and Florida lead in raising it, but their crop is far inferior to the crops of Cuba, Java, Hawaii, and India Those four countries have the necessary hot, moist climate, the right kind of soil, and cheap labor. Consequently they produce nearly all of the world's supply of cane sugar.

In a good many countries, especially in Central Europe, sugar is made from beets also. Of its manufacture we have told you in another article. This product amounts to a third of the total amount of sugar produced in a year. Furthermore, as time goes by more and more farmers are turning to the growing of sugar beets.

And yet, in spite of all this sugar that you have at your disposal, if you ever go to the tropics you must try extracting sugar from the cane itself in the old, old way.

Reading Unit
No. 5

WHY ARE SOME OF THE GRAINS "CEREALS"?

Note: For basic information not found on this page, consult the general Index, Vol. 15.

For statistical and current facts, consult the Richards Year Book Index.

Interesting Facts Explained

The cereal plants, 9-118-19
The food value of oats, 9-119
How Europe got the oat plant, 9-119
Uses of rye, 9-119
Barley, an old friend of mankind, 9-120
Buckwheat, 9-120
Millet and sorghum, 9-120

Things to Think About

What plants are known as cereals?
How important are oats?
Why is rye bread common in Northern Europe?
What important uses has buckwheat?
Why has man chosen wheat, oats, rye, and barley to cultivate?

Picture Hunt

How has the threshing machine helped the farmer? 9-118
How can you tell the difference between the oat and barley? 9-119
What cereal has hundreds of grains bunched together? 9-120
What cereal may be used as bird seed? 9-120

Related Material

What are grasses like? 2-177, 180
Who was the Greek goddess of fertility? 14-407-8
How much destruction to our cereal crops occurs each year because of plant diseases? 2-140
What is meant by a grain elevator? 9-236

Leisure-time Activities

PROJECT NO. 1: Learn to prepare a dish of "rolled oats," 9-119.
PROJECT NO. 2: If possible, pay a visit at harvest time to a farm which grows rye, oats, or other cereals.

Summary Statement

Man's life to-day depends on grasses, whose seeds keep him and his domestic animals alive. Oats, rye, barley, and millet are turned into live stock so that we may have meat. Rye is used in breadmaking, and as food for cattle.

Photo by Inte r Co.

With a fine roar of its engine and an air of efficient haste, the threshing machine brings the grain harvest to a close. In a cloud of dust the men ply the intelligent monster with stalks of ripened grain, and get in return the kernels and the straw, while the "chaff"—or fine waste that comes away when the little grains are freed of their protecting sheaths—is blown like dust before the wind. How many aching arms and backs are saved by this invention and how much time! In days gone by, the oats that are being threshed in the picture would have been beaten by hand with a flail to loosen the kernels; and then the grains would have been shaken by hand in a kind of sieve, to "winnow" them of the chaff.

WHY ARE SOME *of the* GRAINS "CEREALS"?

Which Are the Best of Them, and What Are All the Things They Are Good For?

IT IS hard for us to realize that if it were not for the grasses, man could not exist on the earth. But if you have read our story of those humble plants, and our accounts of some of the most valuable of them—of wheat and corn and rice—you will know that they give us our most important foods. These are known as the cereals (sē′rē-ăl), and they all bear their seed in the form of a grain. They differ from the fine green grass that covers our lawns with velvet in that they must be sown every year, whereas our lawn grass springs up from the roots, which live over the winter.

You remember the story of Ceres (sē′rēz), the Roman goddess of grain and of the harvest—how her daughter Proserpina (prō-sûr′pĭ-nȧ) was kidnaped by gloomy Pluto (plōō′tō), god of the realm of the dead, and carried away to the lower world to be his bride; and how the grief-stricken mother searched for her everywhere, neglecting meanwhile her great duties, so that harvests failed and famine covered the earth. Of course something had to be done to restore the fainting land; so, as one version of the tale goes, Jupiter, king of the gods, learning what Pluto had done, persuaded him to give up the bride for a part of every year, that she might come back to her mother and the earth be fruitful again. And that is why we have winter and summer—the growing season, and the icy cold, when all the green things die because Ceres is spending all her time mourning for her daughter. And that is why we call the useful grains after the goddess who once was thought to preside over their growth.

We are so used to thinking of wheat and corn and rice as being the important grains, because they are eaten by man, that it is a surprise to learn how certain others are raised in very large quantities, and form an important part of the farmer's crop because he

uses them to feed his cattle. Without them we should not have our juicy beefsteaks and savory bacon. These other cereals are oats, rye, and barley, all well-known in the Temperate Zone; and millet and buckwheat, the last not really a grass but usually included in the cereals because it bears a grain.

The sturdy grain that comes to the breakfast table in the shape of "rolled oats," is richer in food material than any other cereal, and wherever it is a staple diet—as in Scotland, for instance—the people are strong and healthy. But it cannot be ground into a flour that is suitable for bread, and the meal into which it is ground, in other countries than the United States, can hardly be used for much except to make porridge or small oatcakes. So it is never eaten so widely as wheat flour.

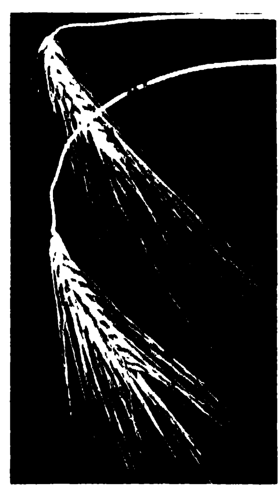


Photo by Dept. of Agriculture, Ottawa, Canada

Nature took just as much pains in making the humble grain as she did in making the most magnificent elm tree or the rarest orchid. Above is the dainty oat stalk, and to the right is barley, which is often seen in art because of its delicate grace.

Nevertheless, there are nearly as many bushels of oats grown as there are of wheat or corn, for besides all that are used for human food, they make an excellent food for animals, and their straw can be turned into a coarse paper. The world uses several billion bushels of oats a year; of this the United States, Russia, Germany, Canada, and France raise the most.

We do not really know where this cereal came from. It was never eaten in Bible times, nor by the Greeks or Romans. The people who lived in the Swiss lake dwellings so many thousands of years ago knew about it. So we suspect that it came into use in Central Europe, where many varieties of it grow wild. It may have been brought there from Russia or Western Asia at a time when other crops had failed. There are a number of wild oats growing in America, all of them serious weed pests, but the oats we grow for food were brought over by the colonists—and strangely enough, the oats grown in the southern part of this continent came from a variety that grows wild in Southern Europe and Northern Africa. There are a great many kinds of cultivated oats, and there is a considerable difference in the way they bear their grains; but all of them are hardy and may be planted early without fear of late frosts. That is one of the things that makes the oat so valuable in northern climates.

Rye is a close relative of wheat, and like wheat is used for making flour. But unlike wheat, it will grow on very poor soil and in a very cold climate. So it is used for making bread in the countries of Northern Europe, and in many other places it is used for fodder for cattle or in making certain kinds of alcoholic liquors. Because it is taller than wheat and has a coarser stem, its straw is of value for making hats; it is also used in the manufacture of paper.

Most of the world's supply of rye is grown in Europe or in North America, with Russia producing more than half of it, and Germany coming second. Our own crop amounts to tens of millions of bushels a year.

Like oats, rye is something of a newcomer in the world's family of cereals. None of the older peoples knew it, but it has been grown in Central and Northern Europe for a long time. It is thought to have originated around the Caspian and Black seas.

If rye and oats are comparatively a new discovery of the human race, barley is one of our oldest friends. It was one of the first cereals known to man, and was grown by

the early Egyptians, the Hebrews, and the Chinese. Its first home was probably in Western Asia, but it was so hardy that it spread almost wherever men were found, and nowadays it has a wider range than any other cereal. From Iceland, Alaska, and Northern Russia to Egypt and India this age-old grain is raised, and to-day there are a number of different varieties of it in common use.

But it is not so much employed for food as it used to be. Its flour is not suited to making bread, and cattle cannot eat it for fodder because of its bristles, though the grains may be ground and fed to them along with other ground grains. Its principal use to-day is for the making of malt. In the United States it is of great importance among our cereals; but Russia exceeds us in production. She grows nearly a third of the crop that the world uses every year.

To those of us who live in the United States, buckwheat suggests just one thing—the buckwheat cakes that make such an appetizing breakfast. But the curious, three-sided grain is also used for feeding stock and poultry, and the fragrant flowers are always buzzing with a thousand bees that come to gather their honey. A field of buckwheat must be sown late in the spring, for the plant—an Asiatic member of the dock family, and related to smartweeds and knotweeds—is sensitive to cold. The crop is so accommodating—it will grow on such poor soil and is so lusty in killing weeds—that, like rye and oats, it is often grown and plowed under when land needs enrichment. In England it is grown for the pheasants, who love to feed on its seeds. In mild climates two crops of buckwheat may be raised in one season, for it matures quickly. The United States grows millions of bushels of it a year, and it is produced in Central Europe and in Asia as well. There it is used rather extensively for food, though it is fairly low in food value.

To say just what millet is, is not very easy. It is a name given to many different kinds of grasses, the seeds of which furnish food for a third of the earth's population. In England and the United States these grasses are used mostly as forage. There is broom-corn millet, foxtail millet, pearl millet, cat-tail millet, black millet; Japanese, Chinese, Indian, Egyptian, and African millets; kafir corn, guinea corn, milo maize, feterita, and durra, which is cultivated almost everywhere in Africa and is the most important cereal there. The United States Department of Agriculture groups the varieties of millet raised in this country under sorghums, and explains that kafir corn, milo maize, feterita, and durra are included.

Some kinds of millet are only three feet high, others grow as high as sixteen feet. Some come up from the roots year after year; others are annuals, like most of our cereals. Some produce five times as much grain to the acre as wheat, and may be ground into a flour that makes excellent bread when mixed with wheat flour. Many of them make fine cattle fodder, and in this country one variety yields a sweetish juice that is manufactured into molasses. In France the same kind is used in manufacturing alcohol. In India many millions of acres of land are sown to a millet known as jowari. In the United States the various "sorghums" (sôr′-gŭm) cover several million acres, and bring the farmers a handsome sum every year.

This pretty stalk belongs to the all-embracing millet family, the different varieties of which grow all over the world.

Photo by U S Dept of Agriculture

Millet serves many different purposes. Some varieties make bread; others can be used in soup; still others make excellent bird seed!

Reading Unit
No. 6

IN THE OLD DAYS OF "SUGARING OFF"

Note. For basic information not found on this page, consult the general Index, Vol. 15.

For statistical and current facts, consult the Richards Year Book Index.

Interesting Facts Explained

"Sugaring off" camps, 9-122
When maple sugar is collected, 9-122
How maple sugar used to be obtained, 9 122-24
Why a piece of pork was hung over boiling maple sugar, 9-124
How maple sugar is made today, 9 124

Things to Think About

Why are tubes put into maple trees?
How long is the maple sugar season?
Why must maple sap be boiled down to a thick sirup?
What is the chief use of maple sugar as we use it today?
Why has maple sugar production fallen off?
Where does most of our maple sugar come from?
Why do we use more cane sugar than maple sugar?

Picture Hunt

How much maple sugar is made in Europe each year? 9 122
Why is a maple tree tapped on the sunniest side? 9-123
Why are sleds used by the workers? 9 123

Related Material

How does the maple tree make sugar? 2 235-38
How does the maple tree use the sugar it makes? 2-237
How do we get sugar from sugar cane? 9-114-16
How do we get sugar from sugar beets? 9 120-27
How do substances evaporate? 1-405-8

Leisure-time Activities

PROJECT NO. 1: To make maple sugar candy, follow directions on page 14-85.

PROJECT NO. 2: You can earn some extra money by making candy. See 14-87.

Summary Statement

Maple sugar comes from the sugar maple. Early in the spring, when the snow is yet on the ground, the trees are tapped and the sweet sap flows, drop by drop, through the spout and into a bucket. The sap is thin, and workers must boil down or evaporate it until a rich sirup forms. This is bottled and sent all over the world or, boiled till it sugars, is used to make candy.

Photo by Canadian Pacific Ry

Maple sirup and maple sugar are made only in America. If you ask a European whether he likes maple candy, he will say that he has never tasted any. In some years the snow is still on the ground when the sap begins to run. Then men use skis to gather the sap and may pause for a delightful dip into the sap pail.

In the OLD DAYS *of* "SUGARING OFF"

A Tale of the Gay Times That Peoples Used to Have When the Sap Was Running in the Sugar Maples

ARE you ever tempted to wonder how people had any fun a hundred years ago, when there were no radios, no automobiles, no baseball, and no "movies"? If sometime you should find yourself in that self-satisfied frame of mind, in which every thing outside your own time and country seems very dull and tiresome, just stop a moment and remember the old-time "sugaring off." There probably is no fun we know today that brings more real joy than did those gay evenings when everyone in the village went out to the forest on a night in early spring, to sample the handiwork of the crew who had been working day and night in the sugar camp. The place was still and beautiful and mysterious. A huge fire cast flickering shadows on the snow that still lay on the ground, and in the rosy light everyone looked happy. And to people whose chief bonbons were a little "rock candy" and a few hard round "peppermint drops," the hot sugar was a rare treat.

The camp had been busy for a long time—ever since the day in late February or early March when some impatient little boy had stuck his knife into a maple tree and watched the sweet sap come oozing out. He had licked it greedily and then had run off home to shout the thrilling news. At once the grown-up members of the family had begun bustling about, getting out the kettles and buckets and the rest of the campers' outfit; and the men had set off into the silent woods to spend from three to six weeks boiling down the sap.

They had bored little holes, some two inches long and half an inch across, into the trees about three feet above the ground. And in each of these holes, which always slanted upward a little, they had inserted a short tube, or "spile," and had hung a bucket beneath it to catch the drip of the sap. Sometimes a large tree would be tapped in two places.

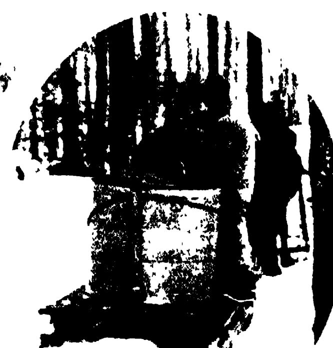
By the time all the trees in the wood had been tapped, the first buckets were ready to be emptied; and then the boiling began.

MAPLE SUGAR

If you live where sugar maples grow why not try making some sirup or sugar? Here is an idea for an Easter present. Drain an ordinary egg through two little holes at either end, and fill the shell with sirup which has reached the sugaring stage. It will harden—and your friend will wonder how you ever got maple sugar inside an egg!

The man above is drilling a hole into a sugar maple. First he carefully brushed the side of the tree with a stiff broom so that no loose bark or dirt would fall into the pail.

It is best to tap a maple on the side of the tree which is least shaded, because the warmth of the sun aids the flow of the sap. Above is the pail which has been hung to catch the drip.



When the pail is full it is emptied and hung up again on the tree. All the sap is gathered together in huge cans and carried by sledge, if there is still snow on the ground, to the rustic camp you see below. There it is sugared off.

Photos by Canadian Pacific Ry, American Musei and U S Departme of Agriculture

Over the great open fire huge iron kettles were hung, and into them went the sap, from fifteen to twenty-five gallons of it from every large tree in the course of a season. The work often lasted far into the night, for though the sap stopped running in the early afternoon, it usually had to be boiled before the next day's yield came in; and to keep the kettles from bubbling over took constant watching. A piece of pork was usually hung over the boiling sirup, and whenever danger threatened, it was lowered into the pot.

After a long day of fetching and stirring and pouring, the men were glad enough to turn into their beds of balsam boughs in the little shack and go to sleep to the hoot of the owl or the distant bark of the fox.

A Modern Sugar Camp

Nowadays the thing is managed much more effectively and less colorfully. Large barrels or tanks are drawn on sleds from tree to tree by horses or oxen, and when the sap has been collected it is emptied into shallow pans set over an inclosed fireplace. These pans, which are two or three feet wide and twice as long, slope just a little toward one side and are divided lengthwise by partitions which are open at alternate ends. So the sap, which enters at one corner, flows slowly along the length of the first compartment, around the end of the first partition, then back along the second compartment, and around the end of the second partition into the third compartment.

By the time it reaches the outlet in the corner of the tank diagonally opposite to the corner where it came in, it has been boiled down to a sirup. If the fire is very hot, a good deal of sap can be let in at a time, for it will boil away fast. If the fire is low, the sap must run through the pan more slowly in order for it to be boiled down enough in the course of its journey back and forth through the pan.

When the sirup comes out of the pan at last, it is thick enough not to spoil easily. Then it is put into cans and sealed for shipment. If it is to be made into sugar, it is boiled down until it is quite thick and is poured into moulds, where it hardens. Through the whole of the process everything is kept spotlessly clean, and the greatest care is taken to keep the precious sirup free from bits of twig and bark.

In the good old days many a farmer in the United States and Canada relied on his sugar maples to give him his year's supply of sugar. In 1860, more than 40,000,000 pounds of maple sugar were made in the United States. But now we use the delicate sirup of the maple mainly for pancakes and waffles, and rely on the sugar cane to give us other sweeteners. So in 1920 the country produced only 10,000,000 pounds of maple sugar, but more than 3,500,000 gallons of sirup—twice the amount produced in 1860. Today maple sirup comes from all the states between Maine and Minnesota and as far south as Virginia and Kentucky, but Vermont produces the most, with New York a close second. In a good year millions of trees are tapped and yield many millions of pounds of sirup and sugar. Canada's output is greater still, with Quebec leading.

Nevertheless, the output of maple sirup would seem to be dwindling—and that, on the whole, is a pity. For not only is it a delicious sweet for everyone, but the black maple and the sugar maple, from which it comes, are among the most beautiful trees in our forests. Tall, stately, graceful, with handsome, shapely leaves, the maple not only gives us her beautiful wood and her sap, but in autumn she dons a garb as gorgeous as any other on field or hill.

The STORY *of* BEET SUGAR

Reading Unit
No. 7

HOW WE GET SUGAR FROM BEETS

Note. For basic information not found on this page, consult the general Index, Vol. 15.

For statistical and current facts, consult the Richards Year Book Index.

Interesting Facts Explained

How cows discovered a new source of sugar, 9–126

How plant breeders improved the sugar beet, 9–126

How sugar beets prolonged the First World War, 9–126

The amount of beet sugar produced, 9–126-27

The growing and handling of sugar beets, 9–127

Extracting and purifying beet sugar, 9–127

Things to Think About

How did watchful farmers discover a new source of food?

How do plant breeders increase the world's food supply?

What enabled the Germans to continue World War I?

To what extent is sugar from beets a rival of cane sugar?

How does the sugar beet differ from red beets?

How is the sugar extracted from sugar beets?

Why is it an advantage to our country to raise sugar beets?

Picture Hunt

Why is it unwise to handle sugar beets roughly? 9–126

Why are beet-sugar factories near the plantations? 9–126

Related Material

What plants provide the world with sugar? 9–113, 116, 123

Why is sugar important in our diet? 2–40

Where does a beet plant get its materials for sugar making? 2–40

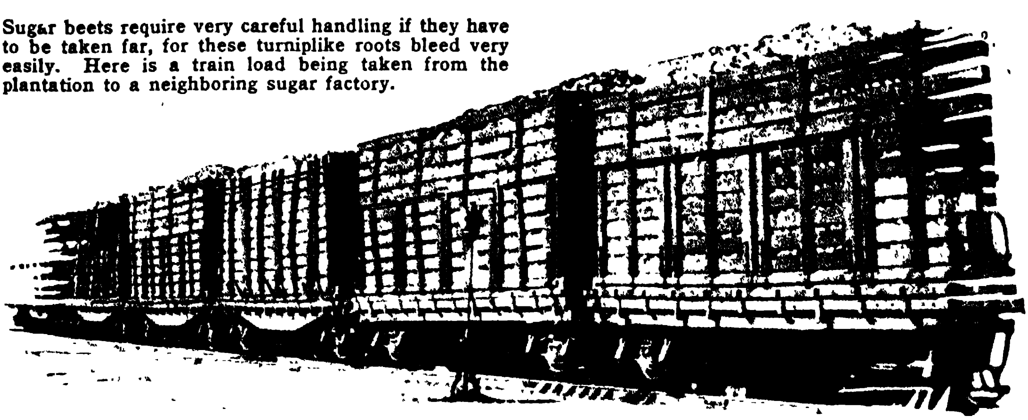
How does the body use sugars? 2–362

How are plants improved? 2–226-33

What was the work of Luther Burbank? 13–416-17

Summary Statement

We get sugar, not only from sugar cane, but from sugar beets as well. There is no difference between the sugars derived from these plants except that beet sugar is white. Factories are built near the plantations because slight injuries cause the root to bleed. The beets are sliced into shreds and the sugary water evaporated. The sugar is then refined and packaged. The remaining beet pulp makes excellent feed for cattle.



Sugar beets require very careful handling if they have to be taken far, for these turniplike roots bleed very easily. Here is a train load being taken from the plantation to a neighboring sugar factory.

HOW WE GET SUGAR *from* BEETS

What Happened When Silesian Cows Found a New Sugar Supply, and How a War Persuaded Men to Use It

JUST before the American Revolution the farmers of Silesia noticed that their cows were very fond of eating the leaves of a coarse biennial herb. The farmers already knew it as a kind of beet, but now they began to grow it almost entirely as forage.

Then its thickened root, longer than a beet and white instead of red, was found to be so much sweeter than the leaves that cattle ate it with relish and fattened on it. Some years later the plant breeders took notice of this "white beet" and began to see what they could do with it.

One of the most famous of the plant wizards was Vilmorin (vĕl′mô′răN′), a Frenchman. When he began work on the white beet it contained only about 5% of sugar, and the root was not much larger than the common red beet of our markets. In a few years of careful breeding he more than doubled the size of the root, and, what was still more important, he increased the sugar content to nearly 20%. So much sugar is rarely found in beets to-day, for some of Vilmorin's plants cannot be grown commercially. But this clever Frenchman did develop a variety that regularly produces 16% of sugar, which is slightly above the sugar content of the sugar cane.

All this was completed before 1860, when Vilmorin died, but growing sugar beets as a source of sugar did not get much of a start until a good many years later. Today some 10,000,000 tons of sugar a year come from sugar beets, which furnish a third of the sugar the world uses.

During World War I Germany was cut off from all supplies of cane sugar, which can be raised only in the Tropics. Her population would have starved for sugar if the Germans had not been one of the first nations to use Vilmorin's improved sugar beet. Central Europe still produces most of the beet sugar in the world, and that fact explains why Germany was able to go on fighting for four years. She might have been forced to stop much earlier without it, for no modern population can get along if it has no sugar. We have come to rely on sugar to give us much of the energy that early man got from eating the various grains. But more than that, we are dependent upon it to make much of our food appetizing, and to help us save our valuable fruit crop by preserving it. Long before World War I a number of countries had begun to grow sugar beets, and today the world's crop has reached sizable proportions, with Russia, Germany, and the United States producing heavily.

The plant can be grown only in temperate regions, since it is a biennial. The first year it simply makes a rosette of coarse, hairy leaves, which live over the winter under the snow. The second season its roots swell, and reach their highest sugar content toward harvest time, when they are ready for the beet-sugar factory.

Colorado and California are the chief states to grow sugar beets, but Montana, Idaho, Nebraska, Michigan, Utah, Wyoming, and Ohio are important. Their fields cover hundreds of thousands of acres. Because the root bleeds almost as easily as the garden beet's does, it cannot be shipped very far, and must be handled with the greatest care. And it is for this reason that beet-sugar factories must be near the fields.

The roots when harvested look like large white turnips. The leaf tops are wrenched off some distance from the top of the root to prevent bleeding, and the roots are then carted to the factory, usually by motor, since the extra handling needed to load them on and off freight cars might start them bleeding. This may not seem very important to us, but as a matter of fact the modern sugar beet is so full of sugar that fermentation from bleeding roots may ruin a whole truck load over night.

Once they reach the factory the beets are cut into thin, shreddy slices called "cossettes" (kŏ-sĕt′) and put into "diffusers." These are metal containers holding from five hundred to twenty-five hundred gallons, depending on the size of the factory. At the top and bottom of each diffuser tank is a trapdoor.

When the diffuser tanks are filled with slices of beets, warm water is forced in at the top of tank No. 1, down through the mixture, and out at the bottom. The tanks are all connected by pipes; so when the sugary water comes out of the bottom of tank No. 1, it is forced in at the top of tank No. 2, and then on into tank No. 3. In this way it is passed through at least ten diffuser tanks.

While this is going on, the trapdoors at the top of the tanks are constantly opening to admit fresh slices of the root, while the spent slices are steadily released from the trapdoor at the bottom. By this automatic device warm water is constantly being forced through fresh slices of beet roots, and makes a continuous stream from diffuser tank No. 1 to the last tank. Sometimes there may be as many as fourteen tanks, but the usual battery is made up of ten diffuser tanks to a series.

By the time the water reaches the outlet it has dissolved out practically all the sugar—but not quite all of it. The spent slices still contain some sugar, as well as other valuable food materials. So they are pressed into cakes or sold in bulk as cattle feed.

Of course the really valuable thing derived from this process is the stream of sugar-laden warm water. This is pumped into tanks in which is put a small amount of lime, which takes out some of the impurities. Heat at about 2,800° F. is applied to the liquid, which is not yet allowed to crystallize into raw sugar. Chemists test it and remove still other impurities, such as lime, various gases, and excess carbon. Then it is finally ready to be crystallized out as "raw" sugar.

Raw sugar contains from 94% to 98% pure sugar, but it is not in the form of white, shining crystals, such as one buys at the grocery. It still has to be refined. Beet sugar is refined in the same way as cane sugar, a process that we have described in our article on cane sugar. Refined beet sugar and cane sugar are chemically the same. They look exactly alike, are of equal sweetness, and both are from 99.5% to 99.9% pure sugar.

The STORY *of* COFFEE

Reading Unit No. 8

BROWN SEEDS FOR EVERY BREAKFAST

Note: For basic information not found on this page, consult the general Index, Vol. 15.

For statistical and current facts, consult the Richards Year Book Index.

Interesting Facts Explained

Coffee has long been known to man, 9-129
Old English coffeehouses, 9-129-30
Brazil, a famous grower of coffee, 9-130
The coffee plant and its berries, 9-130-31
The how and why of roasted coffee, 9-132
Why coffee keeps us awake, 9-132
How good coffee is prepared, 9-132

Things to Think About

How did coffee influence the political and literary history of England?
Where is most of the world's coffee grown to-day?
From what part of the coffee plant do the coffee beans come?
How is good coffee flavor made certain by the wholesalers of coffee?
Why is coffee called a stimulant?
Has coffee done more good or harm in the world?

Picture Hunt

What is a better breakfast drink for boys and girls than coffee? 9-129
On what kind of plant do coffee beans grow? 9-130
How is Colombian coffee shipped from the plantation? 9-131
What part of the coffee do most people never see? 9-131

Related Material

How are coffee beans handled in Brazil? 5-514
How has coffee affected revolutions in Central America? 7-46
Who was John Dryden? 13-173-74
Besides the coffee tree, what other tree is trimmed back to keep it short? 9-135
What plant is used to make a coffee substitute? 9-198

Leisure-time Activities

PROJECT NO. 1: Learn how to prepare good coffee, 9-132.
PROJECT NO. 2: Visit a botanical garden to study the coffee tree.

Summary Statement

Coffee is a drink used the world over. Its stimulating effect is due to the caffeine in the coffee bean. Coffee plants are grown in the tropics, and their red berries picked. These are dried and the beans removed. The beans are roasted and freshly ground for use.

"Two lumps, please, and plenty of cream!" Some people like their coffee black, and some prefer it well disguised with milk; others - and perhaps the wisest do not like it at all, and would much rather have a glass of milk, either hot or cold, to begin the day.

BROWN SEEDS *for* EVERY BREAKFAST

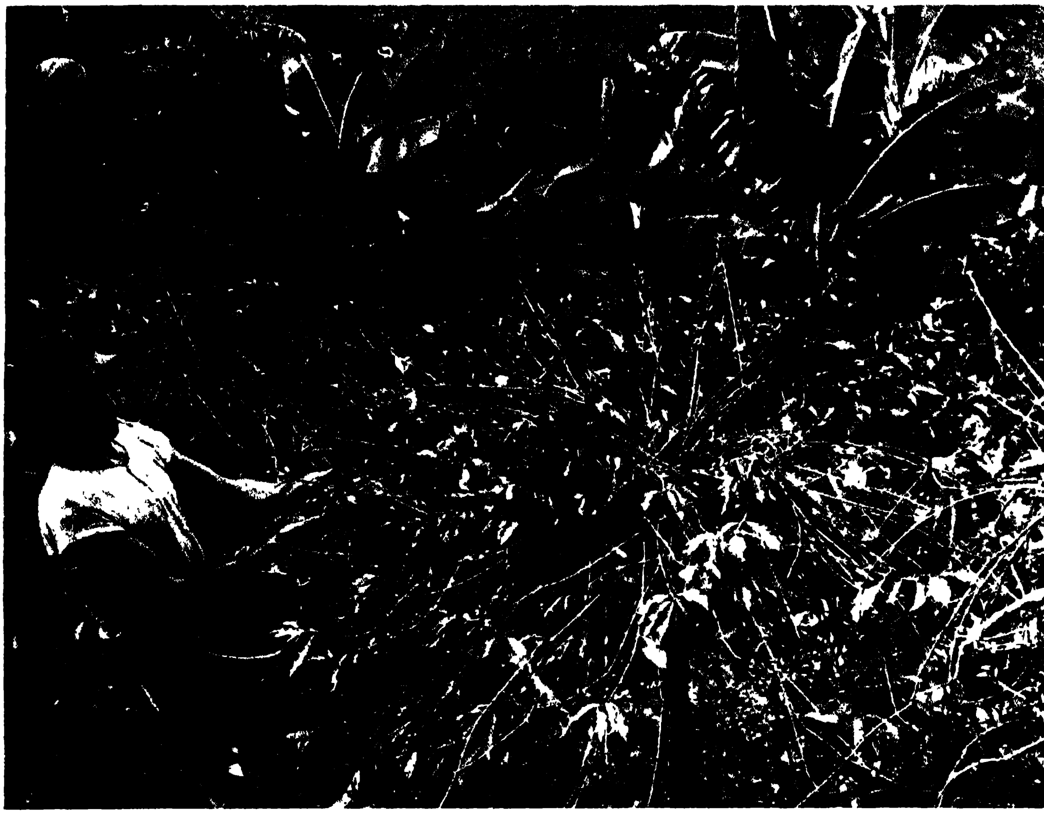
How Our Steaming Coffee Comes to Us from Hot Lands Far Away, and What Happens to It on the Trip

MOST Americans would have a hard time at breakfast without coffee. If they can only hear the merry rat-a-tat of the percolator, it makes fairly little difference to them what else the breakfast table may hold. In a year, we drink nearly twelve pounds of coffee apiece, more than twelve times as much as the British do, for instance.

But before the seventeenth century our ancestors in Europe did not know about coffee at all, though it had long been drunk with delight in Abyssinia and Arabia. Just how long coffee had been known in those lands we cannot tell, but it must have been hundreds of years. There are many legends of how men first discovered it. One legend tells of a group of Christian priests who fled from persecution, about 300 A.D., into the wilds of Abyssinia. They had a small flock of sheep and goats which they herded on the hillsides, and one night the young priest who was tending the animals ran to the prior in great excitement, crying that the herd was bewitched. For with his own eyes he had seen them, at dead of night, romping wildly about the pasture. So the other priests went out to see for themselves, and discovered that the herd had been devouring the leaves of the wild coffee bushes. The prior ate some of the coffee berries; and that night he could not sleep!

If this is really the way men learned that coffee is a pleasant stimulant—that it will make one who drinks it feel more lively—there is still a great deal of mystery as to how men found out that the right way to make it is to roast and grind the seeds in the berries and make a drink out of them. But at least by the fifteenth century, if not long before, men had found out that, too. In Arabia there was as much difference of opinion about drinking it as there has been in America about wine. Many Mohammedans used to keep awake with it during long religious rites, while others said that this was wrong and preached against the use of it. But the drinking of it spread, and coffee became the favorite drink in Arabia, just as tea is in China.

During the seventeenth century the Europeans caught the habit. Coffeehouses began to spring up here and there, where one might



Standard Oil Co. (N. J.) Photo by Collier

Against a background of giant-leaved banana plants which will give him much of his food— this native of Colombia is picking bright red berries. They grow on the coffee trees you see in the foreground

go and sip the strange Eastern drink and chat. The first coffeehouse in England was opened in 1652, and during the gay and witty days of Charles II, of William and Mary, and of Queene Anne, the London coffeehouses were the favorite meeting places of poets and politicians, of gossipers and wits. Should you not like to have seen the poet Dryden in his special chair by the fire at Will's Coffeehouse, or chatted of gallantry at White's, or learned the latest news from France at the St. James? The king frowned a little on the coffeehouses, because he was afraid that so many wits with the warm brew in them might have dangerous ideas. But England, and all Europe, and then America, continued to take coffee.

When Coffee Came to America

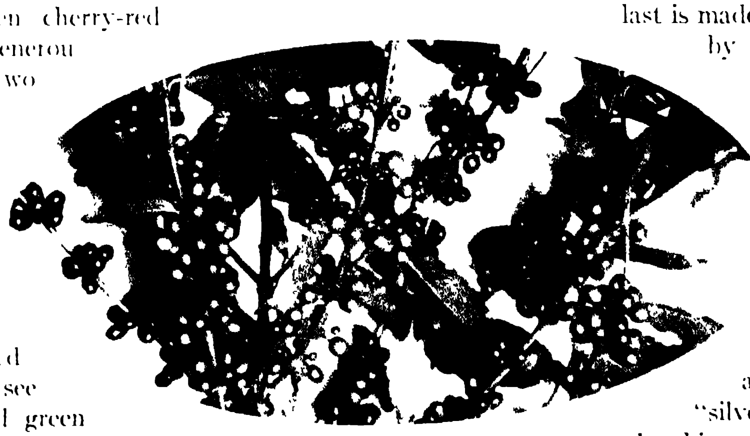
Meanwhile the growing of coffee had spread beyond its native Arabia. Until about 1700 Europe drank only Arabian, or Mocha (mō'kȧ) coffee, still famous for its delicious flavor. But then coffee began to be grown in Java then in Ceylon then in Jamaica finally in a good many places in the New World. The major part of all the coffee in the world to-day is grown in Brazil. There the state of São Paulo, the great coffee-growing region of Brazil, has many thousands of separate plantations, or "fazendas." Colombia, coming next to Brazil, grows a fine mild coffee.

A Glimpse at a Coffee Orchard

Coffee grows only in tropical or semi-tropical lands, and likes best a well-watered hillside between a thousand and four thousand feet above the sea. The coffee plant is a small evergreen tree that grows ten to twenty feet high if it is let alone—though coffee planters usually cut it back so that the pickers can reach the berries more easily. Its leaves are long and smooth and shiny,

In this romantic way coffee we get from Colombia finds its way from the plantation to the point where it will be shipped. Our mule train is entering the town of Manizales, center of a famous coffee region.

and where they join the branch the clusters of blossoms nestle, pure white and very fragrant. The berries are first green, then yellow, then cherry-red In those generou climates, two or even three sets of blossoms can ripen into berries every year, and you will see flowers and green berries and ripe "cherries" all mixed together on the same tree.



These are not sprigs of holly but coffee berries on the branch. Few people see their coffee in this pretty state, for by the time it reaches us, all that remains of the cheerful berries is a pile of brown dust for the percolator.

Now though the leaves of a coffee tree have a coffee flavor—as those sheep and goats discovered so long ago—it is the two small seeds, or "beans," inside each coffee berry which make the only coffee good enough to satisfy us to-day. When the cherries are ripe, they are picked or shaken down on a canvas. Then somehow they must be dried and the beans got out; this last is made more difficult by the fact that, besides the pulp of the berry, there are around the seeds a thin membrane or "parchment" and a layer of "silver skin." On the big modern plantations the beans are taken out by a system of washings in great tanks, rubbings and rakings to remove the pulp, drying in the sun or by artificial heat, and more rolling and rubbing to take off the parchment and the silver skin. At last the beans are graded according to their size, and put into big bags to be shipped.

But before they will give off that enticing aroma, or taste like anything worth drinking at all, the green beans must be roasted to a golden brown. This has to be done very carefully, or the flavor will not come out right. The roasting, which used to be done at home, is now generally done in large quantities at wholesale establishments. All sorts of varieties are blended, and expert tasters are employed to sample each new blend and say whether it is good. After the coffee has been roasted it has to be ground, and when it comes to us from our grocery store it is usually in brown, fragrant particles like sugar or sand. The sooner coffee is drunk after it has been ground, the better it will taste.

The reason that we like to drink coffee when we need waking up in the morning or when we are tired or faint—and the reason some of us cannot drink it at night if we want to get any sleep—is that it contains a drug called caffeine (kăf′ē-ĭn), really the same as the theine (thē′ĭn) in tea, but stronger. This is a stimulant. For the times when we want the flavor without the stimulation, clever manufacturers have made us coffee with the caffeine mostly taken out. Often, and especially in Europe, people who drink much coffee like some ground chicory root mixed with it to make it milder. It has too often happened, also, that dishonest merchants have adulterated coffee by mixing with it chicory or some other root or seed, without saying anything about it. But an expert can always detect such a fraud.

Do you know how to make a good cup of coffee? Knowing how is a sure way to the friendship of many a man and woman. There is a great variety of ways to make it, and you have to learn the taste of the people you make it for. Remember that freshly roasted coffee is best, and that you have to measure carefully and watch your clock. Use a small tablespoonful of coffee to a cup of water—but of course the amount will depend on the strength of the coffee. If you have a percolator, put the water—cold—in the bottom of it, and the coffee in the top. Watch for the water to begin to bubble up into the glass top; then time your coffee according to the strength you want it to have, remembering that if it "percs" too long it will be bitter. Three or four minutes ought to be enough. If you do not have a percolator, you can make very good coffee in an ordinary coffeepot. Mix the coffee with a little white of egg or an eggshell or two, pour on it freshly boiling water, and let the coffee steep or simmer for about five minutes. Then "settle" it by pouring a little cold water down the spout. Many people do not realize that one of the secrets of making good coffee is to have the pot or percolator spotlessly clean.

In France people make a drink called "café au lait" (kȧ′fā′ ô lĕ)—or "coffee with milk"—which is prepared by separately heating equal portions of milk and of coffee and mixing them just before they are served. There and in other parts of Europe a "drip coffee," made in a special pot, is popular.

American coffee experts say the best coffee is made in a pot of the "vacuum" type. Measure the coffee carefully a rounded tablespoonful for each full cup of water and a tablespoonful for the pot. Pour the boiling water into the lower half of the coffee machine and put the coffee in the top. Set the machine over a very hot flame, but as soon as the water has risen into the top reduce the heat, for the water remaining in the bottom must not boil. Remove the pot from the stove after forty seconds, and the instant the coffee has drained into the lower part remove the upper part. Serve at once.

Reading Unit
No. 9

"THE CUP THAT CHEERS"

Note: For basic information not found on this page, consult the general Index, Vol. 15.

For statistical and current facts, consult the Richards Year Book Index.

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Why tea plants are kept stunted, 9-135
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What makes tea "black" or "green," 9-136-38
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Things to Think About

Where does most tea come from?
Why do tea plants need constant care?
How does child labor affect tea growing?
What treatments result in different kinds of tea?
How has the tea drinking ceremony in Japan influenced Japanese and Western art?
Why are Americans a coffee-drinking nation?

Picture Hunt

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Leisure-time Activities

PROJECT NO. 1: Learn to make a cup of real tea, either black or green. Also try to make sassafras tea, 9-138-39.

Summary Statement

Tea, like coffee, contains a powerful stimulant which prevents sleep. The plant is a tree, kept dwarfed, whose tender leaves are picked when young. The leaves are then cured into either black or green tea.

Photo by Presse-Photo, Berlin

In every Japanese home tea is served in a beautiful and simple way, for to the Japanese the beverage is a token of the joy people may get from all the little, common things of life. A man who has no humor is said to have "no tea in him"—and a man with too wild an imagination is said to have "too much tea in him." Tea is served to any guest entering a Japanese home, and a few cups of it close all banquets.

"THE CUP THAT CHEERS"

Samovars in Russia, Dainty Little Bowls in Japan, and the Friendly Teapot on Our Own Tables, All in One Way or Another Help to Give Mankind Its Most Popular Beverage

MANY a century ago, say some of our Chinese friends, a holy Buddhist made a vow that he would not go to sleep for nine long years. He meant to lose no time in slumber, but to devote twenty-four hours a day to holy thoughts. And he almost kept his vow. But after some three years he fell into a doze; and when he awoke he was so disgusted with his weakness that he cut off his eyelids to keep them from ever drooping again. When he threw them on the earth, they took root and grew up into a little tree, and the tree was the first tea plant in the world!

Of course that is only a legend, as the educated Chinese know. But at least it tells us what an old thing tea is in China—though just how old nobody really knows.

It is not so old with us. Only a little over three hundred years ago did the first tea begin to stray into Europe. Even then it was so rare that for a long time no one but a king or a very rich man could afford to drink a cup of it. It had come so far, and at such risk, that a single pound of it might cost what would be equal to four or five hundred dollars in our money of to-day. Many people denounced it as a thoroughly bad thing. Some of them did not even know what to do with a bit of tea if they had it. The poet Southey tells about one family who received a packet of tea and had no

notion how to prepare it. They boiled it like any other vegetable, and then poured off the water and ate the tea with butter and salt.

But slowly tea grew cheaper and its use spread. Slowly the resistance to it died away, and the tax that was first meant in part to prohibit it was given up. And long ago tea had grown cheap enough for anybody. Next to water, it is now about the commonest drink in the world. But it is far commoner in some parts of the world than in others. In the British Isles the average person drinks about ten times as much tea as does the average American, who is likely to take coffee instead; and the people who live in South Africa, Australia, and New Zealand take as much tea as their cousins at home. In China and Japan, and in other parts of the Far East, the people drink even more, partly because it is so hard in some of those lands to get water fit to drink. Boiling the water for tea kills the germs in it.

Photo by [illegible] South Africa

Here is a tea picker at work picking tea leaves on a plantation in Natal, a province of South Africa.

For a long while all of our tea came from China, where it had been grown for thousands of years. It had also made its way into Japan. Only about a century ago did the British begin to grow it in India, and the Dutch in the East Indies, but now a great part of our tea comes from India, Ceylon, Sumatra, and Java. A little comes from various places in Africa, and a little is grown even in the United States. For tea will grow in any warm land where the soil is right for the crop. The only reason, or at least the main reason, why we do not produce more tea in South Carolina and Georgia is that it costs so much to grow tea there. When a Carolina planter has to compete with a Chinese planter who can hire tea pickers for a few cents a day, the Chinese wins. So our tea still comes from the East.

The tea plant is a small tree. It is an evergreen. If it is let alone it may grow thirty feet high, or even higher. But the planter never lets it do this. He is always cutting it down to keep it only four or five feet tall. For that he has two reasons. He wants it to produce less trunk and branch, and far more leaves -for the leaves alone are valuable to him. Also he wants his pickers to be able to reach every part of the bush, and since the pickers are often women and children, the bush must not be too high.

At the start the planter sows the seed of the tea shrub in any suitable patch. As soon as the plants are a foot or so high, however, he takes them up and transplants them to another field, where they grow, as in an orchard, some five or six feet apart. Very often the "orchard" is on a hillside, which may be made into terraces for the purpose.

When the plants are about three years old they begin to yield leaves and buds that are suitable for picking, though the best tea comes from plants that are ten or fifteen years old. From time to time they are pruned to keep them low enough and to make them give more foliage; and when they are about twenty-five years old, they are cut down close to the ground and allowed to grow up all anew from the root.

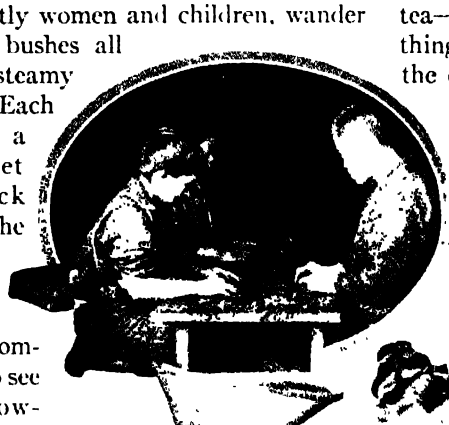
How Tea Is Picked

The spicy leaves are gathered many times a year, just how often depending largely on the warmth of the climate and the consequent rapidity of growth. In the best places the pickers may go through the grove every week or so during the long hot season of

six months or more; in cooler regions they must pick less often. Of course they do not tear all the leaves off the shrub, for we know what would happen to any plant that met such treatment once a week. They have to be very expert in spying the tender new buds and leaves that they want, and still more expert in nipping these off in the right way.

On this mission for tea leaves, millions of people, mostly women and children, wander among the bushes all through the steamy hot days. Each picker has a great basket on her back into which she deftly swings the little leaves. It is no uncommon sight to see little yellow-skinned girls of eight or ten nimbly gathering the tea leaves--and caring for baby brother at the same time!

A good picker will bring in about two hundred pounds of leaves a day. These are all gathered from the tender young buds and blades which the plant is just beginning to put forth. In general, the tenderer the leaf, the more delicate the tea made from it: and our various kinds of tea—orange pekoe, pekoe, pekoe suchong, and suchong—correspond to the age and size of the bud and leaves from which they come. The first of them consists of the buds, and the other three of the leaves in the order of age.



It is not a difference in the variety of the plant but in its cultivation and in the preparation of the leaf that gives us all our different kinds of tea. Often plants of the same kind growing on plantations that are side by side, with apparently the same soil, will produce teas of an entirely different flavor. And of course the size of the leaf makes a great difference. Skillful workers sort out the leaves according to age, as these Japanese are doing. Many experts consider that Formosa, one of the Chinese islands, gives us the finest tea we have—Formosa oolong.

Photos by Keystone View Co

What Makes Tea "Black" and "Green"?

But it is not mainly the kind of leaf that makes our kinds of tea taste so different. It is the kind of treatment, or "curing," which the leaves get between the time they leave the hand of the picker and the time they appear on our tables. For a great deal happens to tea on its way from the shrub to the teacup—with the result that, according to the quality, the tea may at its cheapest make a fairly rank, strong beverage for us, or at its best one of the most delicate drinks in the world. There are many grades of tea—in some countries there are even such things as "tea bricks," pressed together from the coarser leaves and fibers. But the two great classes of tea are the ones that we call "black" and "green," according to the way they have been cured. They both come from the same tree, and the same kind of leaves, but they have been through a different process after picking

The pictures on these pages will show you some of the processes the tea leaves go through. For black tea they are first spread out to "wither" until they are soft and pliable. Then they are "rolled" until the leaves are all broken open to let the spicy juices come out. Next the leaves are allowed to "ferment" for a time, and then they are ready for "firing," or drying in hot air. After this they are sorted into the various grades, according to the sizes of the buds or leaves, and then, after one more "firing," they are ready to be packed for shipment in boxes with a lining of lead. In due time they reach us in the little packets which we buy at the grocery.

All of this work used to be done by hand, and in many a place it is still done in the same tedious way. All through China there are many tea growers who raise just enough tea for their own needs, with perhaps a little to sell. But in the great tea industry the

Photo by Keystone View Co

In the hot, steamy air of Ceylon more tea is raised than in China itself. These Ceylonese pickers will carry their baskets about among the gray-green bushes every day in the year, for there will be no cold period when the plant rests. There are many varieties of tea plant, but only two main types: the Chinese, called "Bohea," and the "Viridis," which is grown in India, Ceylon, and Java. The Indian plants are much larger than the Chinese. Their full-grown leaves are 4 to 9 inches long, instead of only 2 or 3 inches; so of course they give a heavier yield. The little round seeds, about the size of a hazelnut, ripen in November, are then planted in nurseries, and the seedlings set out about four feet apart the next spring.

Photo by Field Mus.

These girls in India are shaking the tea leaves in coarse baskets to remove the largest leaves before the others are sorted. One wonders how much the girl with the baby can earn a day.

work is now done entirely by clever machines, and nothing but the picking of the leaves is left to human fingers.

A Billion Pounds of Tea

For green tea the process is rather different. The main differences are that the leaves are steamed in the first place, and then are not allowed to ferment. This makes a considerable change in the flavor of the product. Whether one prefers black tea or green tea is a matter of taste. In general, the tea from India is almost all black, while that from China and Japan may be either black or green; in England the people drink hardly any tea except the black kind, while in America both black and green tea are used. All in all, the world consumes well over a billion pounds of tea every year.

Why Tea Keeps Us Awake

The active principle in tea is a chemical called "theine" (thē'ĭn), which is the same thing as the "caffeine" (kăf'ē-ĭn) found in coffee. It is mildly stimulating, and is fairly harmless to us in small quantities; though a person who drinks a great deal of strong tea may do serious harm to his nerves. Most of us know that theine may keep us awake at night if we are not used to it. The color of tea comes from the "tannin" in the leaf. This is not very good for us either, in strong quantities, and that is why we should never allow our tea to steep long before drinking it, for steeping draws out more and more of the tannin from the leaf.

Drinks We Make of Other Leaves

There are plenty of other kinds of leaves besides those of the tea plant, which make a sort of tea. Coffee leaves are often used in the lands where coffee grows. In South America you can get a drink called "Yerba Maté," made from a kind of holly leaf, and sometimes we import a little of this. In Paris you can have tea made out of linden leaves or camomile leaves. There are even persons who get a strong habit of drinking these things. In America we have nearly all had a taste of sassafras or catnip tea at some time or other. And in various parts of the world there are various other kinds of "tea." Often we should wonder how

anybody ever came to like them—but do you remember how long it took you to like tea and coffee?

There are hundreds of ways of serving tea besides the ones we know so well. It may be made so black and strong that it will almost tan your stomach, or it may be very weak and delicate of flavor. It may be

taken all by itself, or with sugar, cream, or lemon, with cinnamon or various kinds of spice. In American summers it is often iced. It may appear on the breakfast table, as commonly in England, or at any other meal. It always appears at "afternoon tea" which in France is called a "five o'clock" and in England is actually a light fourth meal in the day.

Courtesy Thomas J. Lipton Inc.

Above, dusky natives are unloading chests of tea from boats to the wharves at Colombo, leading city of Ceylon. All together, their country sells to the world nearly 25,000,000 pounds of tea a year.

At the right, tea tasters are at work at their exacting calling. They test for flavor, color, and fragrance, and can identify between 1,500 and 1,600 different teas can tell where a tea was grown, what it should cost, and how it should be blended to sell to best advantage. They must have years of experience.

In Japan there is an elaborate ceremony that goes with taking tea. The serving of it has been made almost into a religion—the religion of the art of life. For in that country of exquisite taste and politeness even the simplest acts have an inner meaning. The Japanese ceremony of tea drinking was taken directly from the customs of certain Buddhist monks more than five hundred years ago. It was gradually perfected by various "tea masters," or gifted hosts, until it came to be an expression of the Japanese sense of beauty in all the little, simple acts of life. For there is no small and no great, a Japanese tea master would say, it is by making beautiful all the humble acts of every day that we must find perfection. And of course perfection is always perfection, no matter where we find it.

So the taking of tea came to be a kind of ceremony for the worship of purity and refinement. It took place in a little house of its own, the tiniest and simplest of little houses, consisting of a room usually ten feet square—just large enough for five persons—and a little anteroom where the tea things were kept. Outside was a kind of portico where the guests gathered to wait until the scent of burning incense told them that tea was ready. Then they followed a little garden path to the tea room. That path was as carefully planned as the tea room itself, for its simplicity and quiet shade must calm the mood of the guests and prepare them for the peace and dignity of the ceremony before them.

They entered the tea room through a door

that was never more than three feet high—a reminder that pride must be left behind if one is to enjoy what is beautiful. Everything inside was of the most rigid simplicity, for it was the host's ideal to imitate a refined poverty. Yet the tea room was so exquisitely constructed that it cost more than many a mansion, and more thought had been given to its details than was spent on an elaborate temple. All its colors were sober, the lights were soft, and nothing was allowed to look new except the bamboo dipper and the snowy linen napkin. Everything was of the most exquisite cleanliness, but even the cleanliness must be unpretentious, too. If water dropped from a vase of flowers it was not wiped up, for water is clean and its presence there seemed unstudied and natural.

The host's greatest pains had been spent upon choosing and arranging the one object of decoration that the room was allowed to have. This was sometimes only a single flower or a vase of flowers. Sometimes it was a piece of priceless pottery, or, at other times, it might be a beautiful picture. But whatever it was, it was always a masterpiece.

As the four guests came in, they each one bowed before this masterpiece, and no word was spoken, no sound was heard except the soft murmur of the water boiling for the tea. And even here, art had entered in, for at the bottom of the kettle were pieces of metal to help the kettle make its cheerful music.

This is a typical Japanese tea farmer and his hard-working family. They live in the province of Kioto, where the best green tea is raised. For the choicest grade of all, the bushes are covered with a fine net, which only the tiniest buds can push their way through. These are picked and made into a tea which is very costly indeed. It is the one used in the Japanese tea ceremony, and rarely finds its way outside of Japan.

Silently the soberly clad guests drank their tea, made and served according to a careful ritual; and no jarring tone, no vulgar pretentiousness or display was allowed to interfere with their peaceful contemplation of the beautiful object that they had been invited to admire.

You may wonder why we have gone into such detail in describing this simple Japanese custom. It is because the tea ceremony has had tremendous influence. It has affected all Japanese art, and indirectly has affected our Western art as well. It is a pity that its gentle spirit could not have prevailed over the stern and cruel militarism that for so long has directed the lives and minds of the Japanese people.

The STORY *of the* POTATO

Reading Unit
No. 10

A VEGETABLE WE EAT WITH EVERY DINNER

Note: For basic information not found on this page, consult the general Index, Vol. 15.

For statistical and current facts, consult the Richards Year Book Index.

Interesting Facts Explained

What Julius Caesar never ate, 9-142

How civilization obtained potatoes, 9-143

How the potato saved the lives of millions of people, 9-143

Why the potato is nourishing, 9-144

How potatoes are used, 9-144

How potatoes are planted, 9-145

Sweet potatoes and yams, 9-145

Things to Think About

How can a cook prevent the loss of a potato's flavor?

What are some unsuspected relatives of the potato?

Why does the farmer always plant only pieces of a potato and not the seeds?

Would people be better off if they ate more potatoes and less wheat?

Picture Hunt

How does a modern farmer dig his potatoes? 9-142

How long have white men used the potato? 9-143

What is the enemy of a potato grower? 9-144

What is one of the most famous varieties of potato? 9-144

Related Material

What insect helps decrease our potato crop? 3-330

What plant diseases are deadly to potatoes? 2-136-37

What does the potato plant look like above and below ground? 2-31

Why must we plant pieces of potatoes with "eyes" on them? 2-32

What plant can be grafted on a potato? 2-262

How was the Burbank potato "invented"? 13-417

How did the King of France get people to eat potatoes? 2-136

How did the lack of potatoes influence Irish emigration? 2-136-37

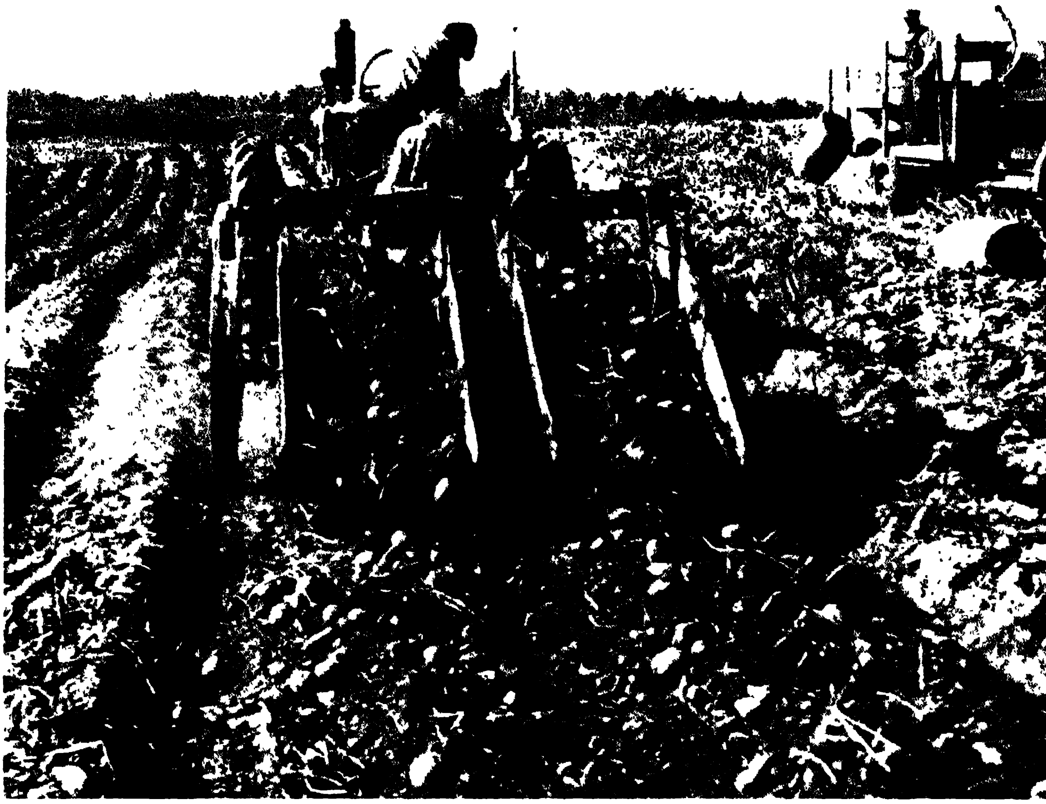
Leisure-time Activities

PROJECT NO. 1: Plant pieces of potatoes with "eyes" in some earth. Watch them daily.

PROJECT NO. 2: Add a few drops of iodine to a slice of cooked potato. A blue-black color shows the presence of starch.

Summary Statement

Potatoes have been known to civilized people for only four hundred years. They have supported whole nations; and in times of potato scarcity, famine has caused great numbers of people to move to other lands.



Courtesy U. S. Department of Agriculture Extension Service. Photo by [illegible]

In the Aroostook Valley in Maine, one of the great potato districts in the United States, this two-row digger is at work saving many back-breaking hours with a hoe. The crop will be carried away in barrels

A VEGETABLE WE EAT *with* EVERY DINNER

Whether or Not We Have Beans or Peas, We Have Somehow Come to Feel that We Must Always Have Potatoes

IF YOU could have sat down to dine with the great Alexander or with Julius Caesar, you would probably have left the table feeling that you had had a pretty poor meal. This would not be because you had not had enough. The amount of food served—and eaten!—would probably astound you. But you would come away feeling ill-fed, just the same, for there would be a great many things you would have missed. The fact that until fairly recently people still spoke of dining as "sitting down to meat" will in itself give you a very good hint as to some of the dishes lacking from an ancient meal. Caesar never tasted a raspberry or an orange, a tomato or lima bean, sweet corn or squash or pumpkin. And the fact that it is only about a hundred years since sugar came into general use will give you another hint from which you can draw your own conclusions. There was no apple pie or ice cream in Caesar's day!

Now the absence of so many savory vegetables and toothsome desserts would in itself be enough to make the Roman fare seem very tame. But even these would not be the things one would miss most. It is safe to say that after a month as Caesar's guest the thing you would most long for would be a good baked potato. If you will think a

Photo by Sacramento, Calif., C. of C.

How glad a cave man would have been to own one of these bulging sacks – and how glad Alexander the Great, or even William Shakespeare! For potatoes are among the most delicious and nourishing of our staples of diet, and yet it is only for the last century and a half that they have been in general use.

moment you will know how thin our modern meals would seem without that humble vegetable, one of the most valuable things the Spaniards found in the New World.

The World's Most Popular Vegetable

Four hundred years ago the potato was unknown to civilized people. To-day it is one of the most widely distributed of all vegetables, holding the first rank as a staple food throughout Europe, where the greater part of the world's total crop of billions of bushels is raised every year. The United States raises hundreds of millions of bushels a year – several bushels for each person.

It is hard to say just how and when this useful vegetable first traveled across the ocean to Europe. Its story seems to have been a good deal mixed with the adventures of the sweet potato, another probable native of the New World but quite unrelated to its white rival. It is thought that the white potato was taken to Spain, from its home on the Pacific coast of South America, after the year 1580. That it was introduced into England by Captain John Hawkins may perhaps be true, but that Sir Walter Raleigh first planted it in Ireland is probably a myth.

In our own country it was first cultivated in the regions now known as Virginia and North Carolina, but the people of New England had to wait for it until it was brought over to them from Ireland in 1719. In 1760 it migrated to France, and at the opening of the nineteenth century it was used in pretty much all civilized countries in the world. From the little wild potatoes that grew in Columbus' day several hundred varieties have been developed, and every year they bring in more money than all the gold and silver that is taken from the mines.

How the Potato Prevented a Famine

The potato has had a most honorable history. Less than a century after it was brought to Europe it saved the lives of millions of people, whose normal food supply had been cut off by the ravages of the Thirty Years' War. Their horses and cattle had been taken from them, and most of their mills had been destroyed, so that they could not grind their grain. Then it was that the potato came to the rescue. It could be raised in small lots, and with no other implement than a hoe. In Ireland it became the staple food of the people, with the result that to-day

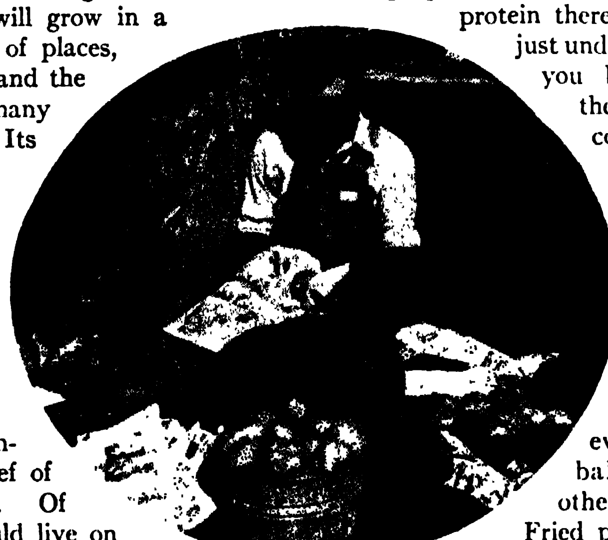
Photo by U. S. Dept. of Agriculture

Here are miles of happy hunting ground for the potato bug! But the chances are very good that the pest may never get a start in this potato field. For farmers are not hospitable to members of the bug tribe.

we always speak of it as the "Irish potato," to distinguish it from the sweet potato.

And the Irish have chosen well. Not only does the potato yield a great deal of food per acre, but it will grow in a great many sorts of places, and does not demand the rich soil that many other crops need. Its food qualities are admirable, for though three-fourths of it is water, it contains from twenty to twenty-five per cent of starch, besides some sugar and valuable mineral salts, the chief of which is potash. Of course no one could live on potatoes alone, for protein (prō'tē-ĭn), the substance that repairs waste, would be almost entirely lacking, as would certain valuable properties that we get from green vegetables. But with meat, fish, or eggs and a little butter it is an ideal food.

And more than that, the potato possesses the great virtue of being easy to prepare. Most people make the mistake of peeling potatoes before boiling them—and that really is too bad. Not only is it a waste of time, since potatoes will cook quite as well in their jackets, but in the peeling certain valuable food properties are sure to be lost, since what protein there is in a potato lies just under the skin. So when you boil potatoes, peel them after they are cooked; the flavor will be the better for it. Of course, it is the baked or roasted potato that possesses the finest flavor of all, and is said to be most digestible. The fire should, however, be a hot one for baking or roasting; otherwise boiling is best. Fried potatoes are a good deal less digestible than potatoes baked or boiled, but of course they contain much more nourishment.



Courtesy U. S. D. A. Extension Service. Photo by G. W. Ackerman

For his project as a member of a 4-H Club for young farmers our boy has raised these fine Irish cobbler potatoes, a famous variety. He is wrapping them before sending them to be exhibited at various county and state fairs. Irish cobblers have an unusually delicate flavor.

Both flour and starch can be made from potatoes; and in Germany large quantities of potatoes go to the manufacture of a kind of alcohol that is used for motor fuel instead of gasoline.

The potato has some very well-known relatives. It belongs to the nightshade family, of which the tomato, the red pepper, the

eggplant, tobacco, and the petunia are all members, as well as the deadly nightshade, a poisonous plant which gives us the medicine we call belladonna. The potato too may be poisonous; its pretty wheel-shaped flowers of purple or white produce a soft green berry that no wise person will eat, and if the potatoes themselves are allowed to lie on the top of the ground till they turn green they too will develop the same poison. Such potatoes should never be eaten, nor should potatoes which have developed large sprouts.

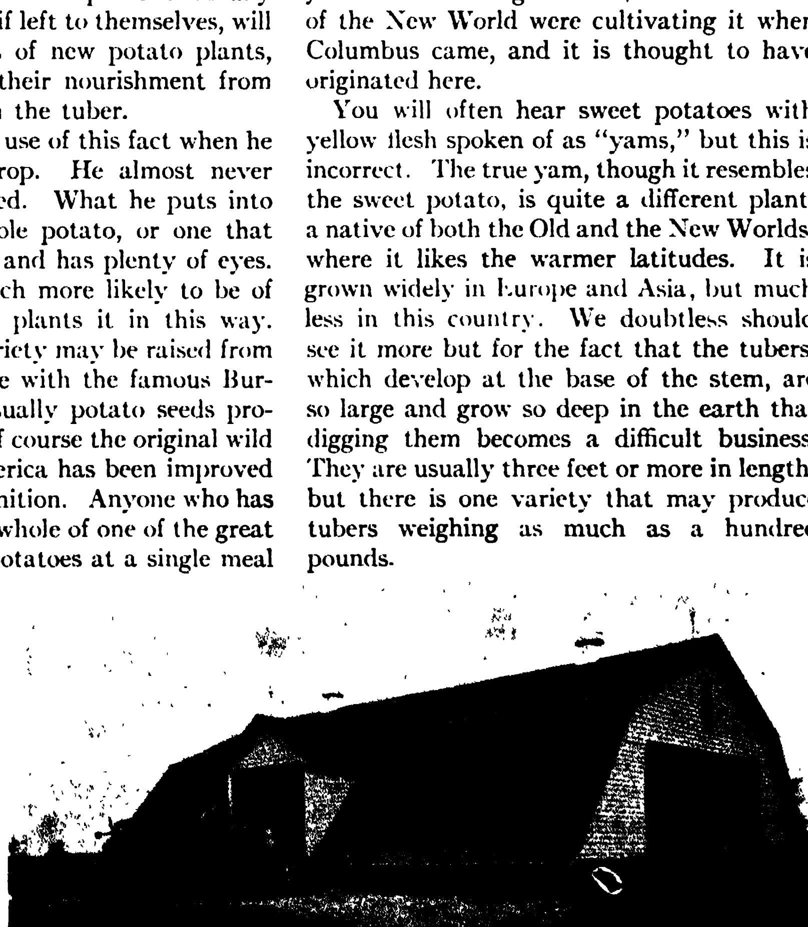
Anyone who has ever dug potatoes will probably think that what we eat is the root of the plant; but strangely enough, though the potato we eat grows under the soil, it is not a root at all. It is what is called a tuber, and is nothing more nor less than a swelling at the free end of certain leafless shoots or branches that have taken to an underground way of life. The "eyes" of a potato are really tiny leafbuds which, if left to themselves, will grow into the stems of new potato plants, which at first take their nourishment from the starch laid up in the tuber.

The farmer makes use of this fact when he plants his potato crop. He almost never plants the actual seed. What he puts into the ground is a whole potato, or one that has been cut in half and has plenty of eyes. His crop will be much more likely to be of even standard if he plants it in this way. Sometimes a new variety may be raised from seed, as was the case with the famous Burbank potato, but usually potato seeds produce a poor crop. Of course the original wild potato of South America has been improved almost beyond recognition. Anyone who has ever tried to eat the whole of one of the great Idaho or Montana potatoes at a single meal will realize this. Sometimes one of these will weigh several pounds.

The sweet potato might well have gained in popularity over the white potato if it had been more willing to grow in northern climates and would keep a little better in our cellars. It is more nourishing than the white potato, since it contains more sugar, and will grow in any warm, sunny climate where it can get a good supply of water. It probably was taken to England before the white potato, and has, therefore, the honor of being mentioned by Shakespeare. But though it is largely raised and eaten in warmer climates, such as the Tropics and the southern parts of the United States, we have never learned to rely upon it much in the north.

The sweet potato is a relative of the morning-glory, and the part that we eat is really part of the root. No one knows for certain just where it first grew wild, but the natives of the New World were cultivating it when Columbus came, and it is thought to have originated here.

You will often hear sweet potatoes with yellow flesh spoken of as "yams," but this is incorrect. The true yam, though it resembles the sweet potato, is quite a different plant, a native of both the Old and the New Worlds, where it likes the warmer latitudes. It is grown widely in Europe and Asia, but much less in this country. We doubtless should see it more but for the fact that the tubers, which develop at the base of the stem, are so large and grow so deep in the earth that digging them becomes a difficult business. They are usually three feet or more in length; but there is one variety that may produce tubers weighing as much as a hundred pounds.



This is the kind of potato barn farmers build in New Brunswick and Maine, two districts famous for their potatoes. You will notice that the building stands on the brow of a hill. Half the barn is below the surface of the earth, but the lower story is entered by a door in the side of the hill, at the left. This saves hoisting the potatoes.

Photo courtesy Maine Development Commission

Reading Unit No. 11

FOOD FROM THE GARDEN

Note: For basic information not found on this page, consult the general Index, Vol. 15.

For statistical and current facts, consult the Richards Year Book Index.

Interesting Facts Explained

The differences between garden crops and field crops, 9–147
Why people have to eat vegetables, 9–147-48
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The cabbage tribe, 9–148
The twenty most important vegetables, 9–150
What goes on in truck gardens, 9–150, 152, 154
Hothouse methods, 9–154

Things to Think About

How did mankind learn to develop good vegetables?
How has the wild cabbage served mankind?
Which are the most important garden vegetables raised?
What activities may be seen on a truck garden?
What vegetables do the animals eat?

Picture Hunt

How do pumpkins grow? 9–148
What kind of bulbs do people eat? 9–148
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What vegetables can you grow in your garden? 9–150
How are melons kept fresh during shipment? 9–152

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How do calcium salts, found in vegetables, affect teeth and bones? 2–315, 320
How have wild plants been turned into useful vegetables? 2–233
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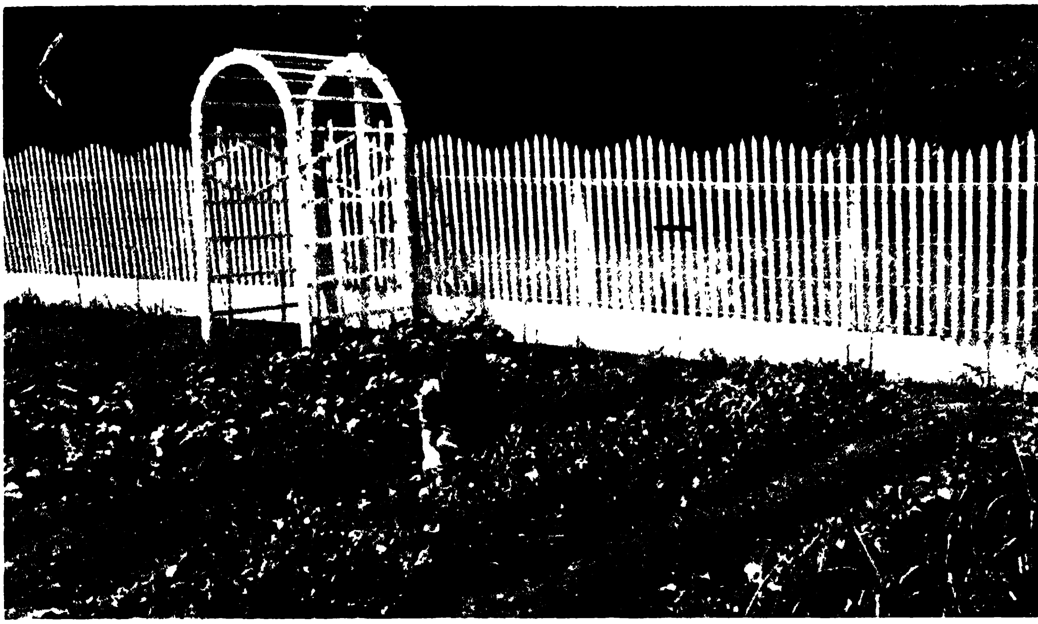
How much water do some common vegetables contain? 2–259

Leisure-time Activities

PROJECT NO. 1: Make interesting "animals" out of some common vegetables, 14–13-14.
PROJECT NO. 2: Visit a truck garden during the growing season. Notice the sprinkling system, weeding, transplanting, harvesting, etc., 9–153.
PROJECT NO. 3: Visit a large market early in the morning when farmers bring their vegetables in by truck.

Summary Statement

Growing vegetables for market is a big industry. Vegetables have been developed by man because they keep him healthy and build blood, bones, and teeth. Most vegetables have been brought here from Europe, though the Indians knew about corn, potatoes, tomatoes, squash, and beans. Plant breeders constantly improve the plants we eat.



Courtesy E. I. du Pont de Nemours and Company

In a world that is growing more crowded every day, home gardens like this one will save money and even lives. So whether or not you have a "green thumb," or gardener's knack, plant food! If you read some simple gardening book and follow directions carefully you will be amazed at the success of even your first venture.

FOOD *from the* GARDEN

Why Farm Crops Need to Be Seasoned with Food from the Garden, and How That Food Is Raised by the Men Who Make a Business of It

NO STAPLE food like wheat or rice is ever raised in a garden. The cereals are field crops that cover millions of acres of farm land all over the world. But without food from the garden man would soon grow tired of wheat and rice, and he might even be poisoned by them if he had no other food.

Farm crops are rich in protein or starch or sugar. They help to make beef and brawn. But they cannot do their best work without the addition of still other plant products. These are various juices and a certain amount of just plain green leaves or stems. Now juices and stems and leaves will not keep fresh very long; and this brings us to the great difference between farm and garden crops. Field crops will keep and can be stored, while most garden crops have to be canned to prevent their spoiling. They are usually best if eaten at once.

Savages nibble wild leaves or chew bark because they know it is one way to keep from falling ill. Even chickens must have their daily ration of grass or some other green stuff. Boys and girls may make fun of spinach or try to get out of eating it; but long ages ago their forefathers learned that fresh vegetables and salads are necessary to keep people well. And scientists, more recently, have shown us that people who do not eat vegetables will develop anemia, will have poor teeth and weak bones, and may fall heir to many other troubles that cause great suffering.

Now men did not need the scientists to tell them this; thousands of years ago they found it out for themselves. From nibbling

stray leaves that did them good, they developed the happy notion of growing other plants that would not only keep them well but would taste better. From those early struggles to tame healthful wild plants have come all the cultivated garden vegetables we grow to-day.

Of course we have many that our forefathers never heard of, and our modern varieties of the old stand-bys are much better than the plants our grandparents knew. But food from the garden has always helped to feed civilized men. Some of our best-known vegetables were used by the Greeks and Romans, and a few are even older still. Four thousand years ago people were eating cabbages, cucumbers, carrots, onions, peas, lentils, turnips, and eggplant. All these originated in Europe or Asia. Many of them first came from the vast area north and west of the Himalayas, which is often thought to be the region where man first lived. It is probably the home of the white race. Of course, other races, too, no matter where they lived, cultivated the vegetables growing in their vicinity.

Many garden vegetables that we use every day are comparative newcomers on the dining tables of men. Some of them were unknown before the discovery of America. The Spaniards spent so much time hunting for gold and killing the Indians that they never bothered about certain entirely new vegetables which those Indians could have told them how to cook and use. So the grasping Spaniards missed a great deal as grasping people usually do. They never learned about lima beans, sweet corn, sweet potatoes, and sweet peppers—all of them American vegetables that the Indians had enjoyed for a long, long time. Nor did they discover the tomato, the squash, the pumpkin, or the tepari bean - New World vegetables that have been in use for some two centuries or less. The Spaniards did learn of the white potato, which the Indians of South America had been cultivating for a long time. Of course to-day the potato, on which we rely so greatly, is grown largely as a field crop, rather than as a garden vegetable.

Perfect vegetables like these do not grow by accident. They are the result of skill and labor—and of patience that never tires and never grows discouraged.

Courtesy The Dow Chemical Company

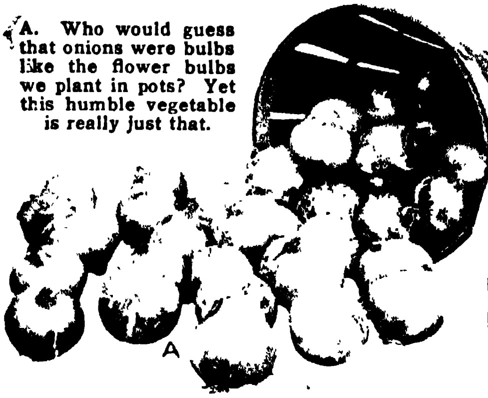
A Flower We Serve at Table

We are used to eating seeds, like peas and beans, leaves, like spinach, or stems, like asparagus, but most of us would be surprised if we were told that one of our favorite garden vegetables was only an immense flower. A little more than two thousand years ago some gardeners in Eastern Europe or Western Asia found certain plants of the cabbage family that had developed a peculiar way of blooming. Instead of sending up a long stalk with flowers at the end, this new plant bunched all its flowers in a fairly loose head, which was partly covered by clasping leaves. From that "freak," or sport, our modern cauliflower has come. The part we eat is simply the much-enlarged flower head.

The Useful Cabbage Family

The cabbage family has been very generous with its sports. Other "freaks" that came from the old original cabbage have been Brussels sprouts, of which we eat a bud; broccoli, of which we eat a loose flower head; kohlrabi, of which we eat the thickened stem; and kale, a low plant with beautiful crinkled leaves that we eat as we should eat spinach or cabbage. All these came from a biennial that still grows in a wild state along the seacoasts of Europe and Western Asia. What the taming of that weed has meant to Ameri-

A. Who would guess that onions were bulbs like the flower bulbs we plant in pots? Yet this humble vegetable is really just that.



C. The cauliflower is well named, for it is really an enlarged flower head.

B. Not very long ago broccoli was a very rare vegetable, but to-day it is becoming very popular D. In this picture you may see the thickened stem of the kohlrabi plant. That is the part we eat. F. A row of cabbages.

E. "Fairy cabbages" might be a good name for the buds we call Brussels sprouts.

Photos by U. S. Department of Agriculture and Norfolk-Portsmouth Advertising Board

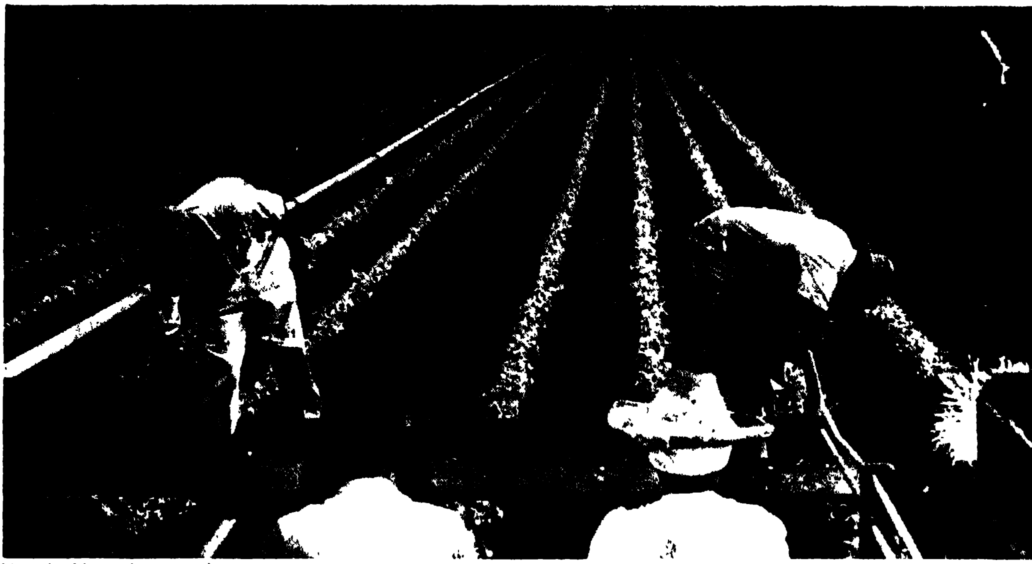


Photo by Florida News and Photo Service

With amazing speed and precision these rows of celery are being set out on a Florida truck farm. All but the tops of the plants will be covered with earth. The pipe at the left will bring water.

can gardeners, coming hundreds of years later, we may see when we visit almost any garden to-day. Many, many thousands of acres of cabbages are grown every year that is, hundreds of square miles.

The Twenty Most Important Vegetables

So many plants are raised in the garden for food that it would be hard to make a list of all of them. But everyone should know at least the twenty most important, where they came from, and what part of them we eat. Here they are:

Vegetable	*Originated in*	*Part Used*
Asparagus	Europe and Asia	Stem
Sweet Pepper	Brazil	Fruit
String Bean	South America	Unripe pod
Lima Bean	Tropical America	Seed
Beet	Europe and Asia	Root
Radish	Western Asia	Root
Cabbage	Europe and Asia	Leaves
Cauliflower	Europe and Asia	Flower
Spinach	Persia	Leaves
Celery	Europe and Asia	Leafstalk
Squash	Tropical America	Fruit
Sweet Corn	Tropical America	Seed
Parsnip	Europe	Root
Carrot	Europe and Asia	Root
Onion	Western Asia	Bulb
Turnip	Europe and Asia	Root
Pea	Western Asia	Seed
Lentil	Western Asia	Seed
Tomato	Tropical America	Fruit
Lettuce	Europe and Asia	Leaves

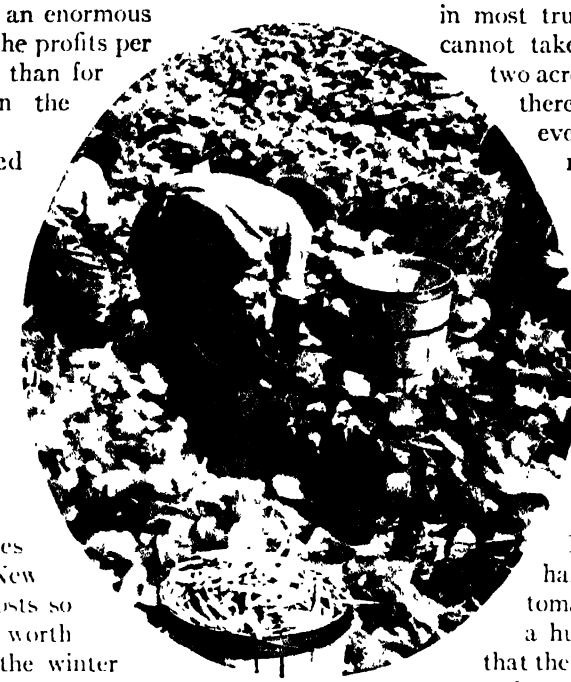
Everyone will think of many others, like the okra, artichoke, leek, cucumber, chives, and cress, but the twenty in the list are by far the most important food plants that come from the garden. The government tells us that millions of dollars are spent every year for these vegetables. And the Department of Agriculture has experts who are constantly scouring the world to see what other food plants we may grow with profit.

What Is a Truck Garden?

Such huge crops need special kinds of gardens, usually called "truck gardens"; the produce from them is called "garden truck." That word "truck" tells a story, for in the days of horse trucks the vegetables could be grown only in places so near to the cities that the produce could be carted to market over night. Of course those horse-drawn trucks are now a thing of the past. Motor trucks and refrigerator cars bring us food from gardens that are hundreds, or even thousands,

of miles away. That is why we can now eat fresh vegetables all the year round, whereas in the old days of real truck gardening we could get them only in season. To-day growing garden truck is an enormous industry, in which the profits per acre may be higher than for any other crop in the world.

A well-managed truck garden is a very different place from the usual home vegetable garden. As a rule it is most successful when it is within motoring distance of some large city. This is still true, in spite of our great refrigerator cars. Hauling vegetables from Texas to New York or Chicago costs so much that it is worth while only during the winter months.



String beans are among our most popular fresh vegetables. All winter they will be picked in this Florida field and shipped north.

Now a truck gardener near a big city must pay a great deal for his land, and this means that rent or taxes are so high that tremendous crops must be raised to make the business pay. So truck gardeners use every inch of space, as we shall see presently. They grow crops so close together that no farm machinery can be used for cultivation, and they are lucky if a small horse-drawn machine can get between the close-packed rows.

Ordinary farm crops are usually sown, cultivated, and harvested by large power-driven machines. Such farming means that one man can take care of many acres. But in most truck gardening a man cannot take care of more than two acres, and for some crops there must be a man for every acre. So many men are needed in even a fairly small truck garden that raising vegetables, while the most profitable form of agriculture, is also the most expensive. It is often said that we are living in the Machine Age. In general that is true. But no machine will hand-weed onions or pick tomatoes, or take care of a hundred different tasks that the truck gardener must perform to make his business pay. Let us see how he raises his crops.

The average crop of cabbage or spinach contains from 80% to 93% of water. A good grower may possibly grow thirty thousand pounds of cabbage on an acre, which means that this crop will contain over twenty-five thousand pounds of water. But during the season it will take up from the soil far more water than it will retain. For every pound of dry matter in the cab-

The roadside stand profits the farmer and the buyer by eliminating the middleman.

Courtesy Bureau of Reclamation

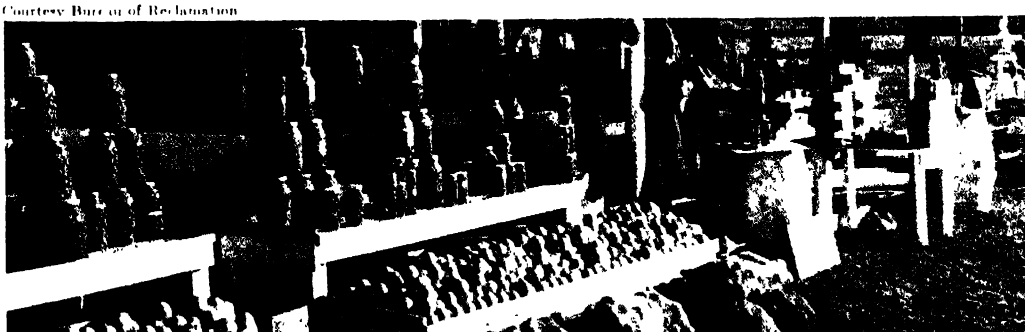


Photo by U.S. Bureau of Reclamation

Under the hot Arizona sun this cantaloupe has ripened. It has a long journey ahead before it reaches its northern market, but the refrigerator car will keep it sound and fresh for the person who buys it.

ages, the plants will have consumed about 600 pounds of water. What if there should be a drought in midsummer? That often happens, with the result that our gardener is ruined if he has not prepared for it.

Artificial Rain on a Truck Farm

Because of the danger of drought, the modern truck garden looks different from any farm. You will find in it an overhead sprinkling system, all of it connecting with a big water tank. Pipes with holes in them extend over all the fields, and by simply turning a valve the gardener can throw a fine rainlike spray over his whole crop.

Expensive land, well-paid men, and a sprinkling system, all these the truck gardener must have before he can plant a seed—and they are all expensive.

But the expense does not end there. The gardener expects such large yields that he knows no soil will stand the steady drain on its plant food. To replace what will be taken from the soil every year, the truck gardener must call on his agricultural experiment station to tell him what kinds of fertilizer he will need and in how great quantities. He knows that he will need a great deal.

For most truck produce the grower will use from a thousand to fifteen hundred pounds of commercial fertilizer to the acre. That costs a large sum, and the proper spreading of it also costs a good deal.

And now that everything is ready for planting, our gardener must set about guarding his crop against insect pests and fungous diseases. For these he needs a variety of pumps, spraying machines, and blowers, as well as hundreds of pounds of chemicals to stop the onslaught of these very dangerous plant enemies.

Are you beginning to wonder if he ever can make any money out of raising food in his very expensive garden? If all goes well he will often make quite a tidy sum; but he will tell you that it is all this expense, before a single load has gone to market, which makes fresh vegetables so costly.

Springtime in Gardenland

In the early spring a truck garden is a very busy place. After plowing, harrowing, and smoothing the land, all of which can be done by machinery, the rows are marked out and

shallow trenches are made for the seeds. The rows are laid out so close together that the full-grown plants will touch each other. The grower is glad when he can plant his seeds directly in these trenches and let them grow there until the crop is harvested. This can be done with such crops as peas, beans, radishes, onions, beets, spinach, sweet corn, carrots, and turnips. For these all he needs to do is keep the growing plants free of weeds, thin out those that are too crowded, and fight their various pests. They never need to be moved until they are picked for market. Then he will often plant another crop immediately on the same soil. For this practice of "double-cropping" in a single season is followed in most successful truck gardens.

What Is a Hothouse?

But a good many of the most valuable vegetables cannot be planted directly in the open ground. Lettuce, cabbage, cauliflower, Brussel sprouts, eggplant, and tomatoes often are started under shelter, long before the plants are set outdoors. This puts another expense upon the truck gardener.

For plants like tomatoes and eggplants, which originated in the Tropics and cannot stand cold, he must often have a greenhouse. That means that he must raise perhaps half a million seedlings under glass. They have to be watched closely for six weeks or so, given just the right amount of heat and water, and then all transplanted, usually by hand. At planting time for such crops the truck gardener will have to hire extra help. Each seedling must be handled tenderly, for while there are crude machines for such work in some crops, hand planting is still the rule in most truck gardens. Planting half a million seedlings is almost like factory work in its speed and precision. The fields are all cross-marked, and a plant is dropped on the ground at every intersection. A second gang follows just behind the first and puts the seedlings in; and so well organized is the work that many acres will be planted in a day.

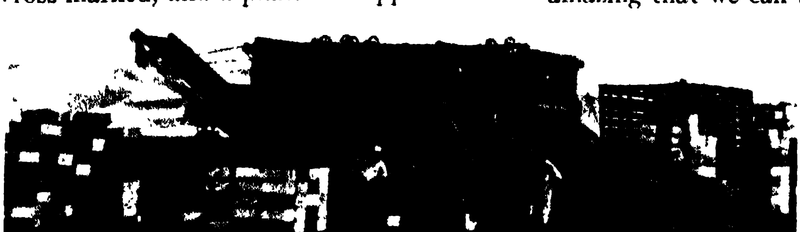
Picking vegetables is much more expensive than harvesting field crops. The truck gardener must do most of it by hand. Some canning-factory gardens use different methods, especially for peas, where the whole plant is cut with a mowing machine and the vines put through a hopper. This not only separates the pods from the hay, but even shells the peas.

But no machine will pick tomatoes or sweet corn, or many other vegetables. So machinery is scarcely used except for getting out root crops like parsnips and carrots. Beets bleed so easily that they are usually pulled by hand and must be handled with the greatest care afterward if they are to be delivered to our kitchens in good condition.

The Gardener's Profit

All this will show you that food from the garden can never be raised without much expensive hand labor. While truck gardening is profitable if well managed, the risks are also great. Even when labor is fairly cheap about a half of what the farmer sells his crop for must go to pay for labor and materials, though in normal years there should be a tidy profit.

Of course there are bad years, but when the crop is scanty the farmer can sell it for more. In other words, truck farmers do not have a gold mine, but they do have a steady demand for their produce, and for anyone with the gardener's knack—or what is called a "green thumb"—the work is pleasant. Truck gardens are growing in numbers, and more and more green vegetables are being sold. It is amazing that we can buy them so cheaply.



On a truck farm in Washington peas have just been harvested vine and all. At once they are vined in these big machines and will shortly be shelled for canning or freezing. Often they are frozen right on the field—to keep the food's flavor.

Courtesy Washington State Advertising Commission

Except for the introduction of machinery, the occupation that Adam originated would seem as little likely to change as any in the world. But no corner of man's life seems safe from the effects of invention, and truck farmers too are wondering when their business will be revolutionized. The new movement began at the University of California about 1930, when William F. Gericke (gĕr′ĭ-ke), a professor of botany, started what he called the science of hydroponics (hī′drō-pŏn′ĭks)—the growing of plants in water.

For seventy years people had known that plants would grow in water when the proper chemicals were added, but no one had tried it on a large scale. Then Professor Gericke began planting tomatoes, potatoes, corn, beans, gladioli, begonias, and many other flowers and vegetables in shallow tanks filled with water. By burning a given plant in a vacuum and analyzing its ashes he found out what proportions of various chemicals the plant needed.

Before long a tank that equaled a hundredth of an acre in area was producing 1,226 pounds of bright red tomatoes. Commercial growers working under Professor Gericke not only took prizes with their tomatoes but were able to grow 100 tons of tomatoes on an acre of water and to sell them at $262 a ton in the winter market. On neighboring farms tomatoes were averaging 12 to 20 tons an acre.

Beans, peas, and other vegetables gave similar yields. From 25 square feet of water 100 cantaloupes were harvested—twenty times the yield from a similar area of soil. Tobacco plants grew to enormous proportions, onions and other garden vegetables throve, and potatoes ran 2,506 bushels to the acre as against the 116 bushels yielded by an average acre of American farmland. On the other hand corn, wheat, and other grains did not do much better than in soil.

It had been Professor Gericke's plan to keep his experiments secret until he perfected his method and could give the farmers practical directions for growing vegetables in water just as cheaply as in soil. But people grew curious when they saw him using a stepladder to harvest his tomatoes, and the secret finally leaked out while it was still in the experimental stage. In 1937 he published his findings, and soilless gardens began to spring up in thousands all over the country. Since this method of agriculture needs only a fraction of the water that is necessary for dirt farming it works well in the desert. City roofs are made to yield like a kitchen garden. Certain railroads and airlines have established soilless gardens to give fresh vegetables to crews and passengers at desert stations and landing fields, such as Wake Island. And during World War II our soldiers were keeping soilless gardens all over the world.

So far this method has proved costly. The chemicals used—calcium, magnesium, potassium, nitrogen, sulphur, phosphorus, iron, boron, manganese, copper, zinc—are not expensive. Enough of them to raise a bushel of potatoes or tomatoes costs less than five cents. But to install and maintain the tanks—which are made of wood, concrete, and metal—is another matter. To convert an acre of ground to soilless farming costs $3000 or $4000. To convert a quarter section costs $640,000. And that is without greenhouses or heating, which improve the yield greatly, since they make it possible to raise crops through the winter, when prices are high. But it should be said that farming with such equipment does away with drought, flood, insects, erosion, and many sorts of pests. There is no outlay for spading, hoeing, raking, and weeding. And the yield is from three to five times as great.

The labor of soilless farming is not very great. The tanks are covered with wire netting which is packed with sawdust or excelsior or some such material that will support the growing plants. The seeds are planted in this material, and as the plants grow they send their roots down into the water below. When they are tall they are fastened to strings hanging from wires stretched overhead. For winter vegetables the water is warmed by electricity till it is just the right temperature for each plant.

Even though soilless farming never comes into common use, Professor Gericke's experiments have taught us a great deal about plant nutrition.

The STORY *of* BERRIES

Reading Unit No. 12

WHERE OUR BERRIES COME FROM

Note: For basic information not found on this page, consult the general Index, Vol. 15.

For statistical and current facts, consult the Richards Year Book Index.

Interesting Facts Explained

What berries mean to a scientist, 9-156

How plant breeders produced our modern strawberries, 9-156-57

How we grow our strawberries, 9-157

Blackberries and raspberries, 9-158

How the loganberry was developed, 9-158

Gooseberries and currants, 9-158-59

How plant breeders developed a race of giant blueberries, 9-159

How cranberries are grown, 9-159

Things to Think About

What makes strawberries fit to eat?

What methods produced our large strawberry?

How did strawberries get their name?

How can you tell the difference between blueberries and huckleberries?

What clever device enabled scientists to give us giant blueberries?

What animals besides man are fond of berries?

Picture Hunt

What is the difference between wild and domestic strawberries? 9-156

In what kind of ground do cranberries grow? 9-157

How do cultivated blueberries differ from the wild ones? 9-158

What is the ancestor of the loganberry? 9-159

Related Material

What do we owe to Luther Burbank? 13-417

What makes bogs shaky underfoot? 2-85

How are wild berries spread over the country? 2-212

What fruits are real berries? 2-120

How are peat bogs formed? 3-28-29

Leisure-time Activities

PROJECT NO. 1: In the spring, look for wild strawberry plants. Study the runners along the ground to see how the plant can reproduce quickly without flowers, 9-157.

PROJECT NO. 2: Learn how jam is made from berries.

Summary Statement

The giant strawberries are the result of constant crossing of different plants by plant breeders.

The large blueberries were obtained by selecting for planting only the large ones found wild.

These large, firm strawberries are very different from the tiny red berries you can pick wild in the fields in spring. They are a good example of how the plant breeder has been able to improve on nature. Yet big and beautiful as they are, they cannot equal their wild cousins in flavor or in sweetness.

Photo by U S Department of Agriculture

WHERE OUR BERRIES COME FROM

How We Came to Have Juicy Strawberries, Luscious Raspberries, and the Tart Red Fruit That Sets Off the Christmas Turkey

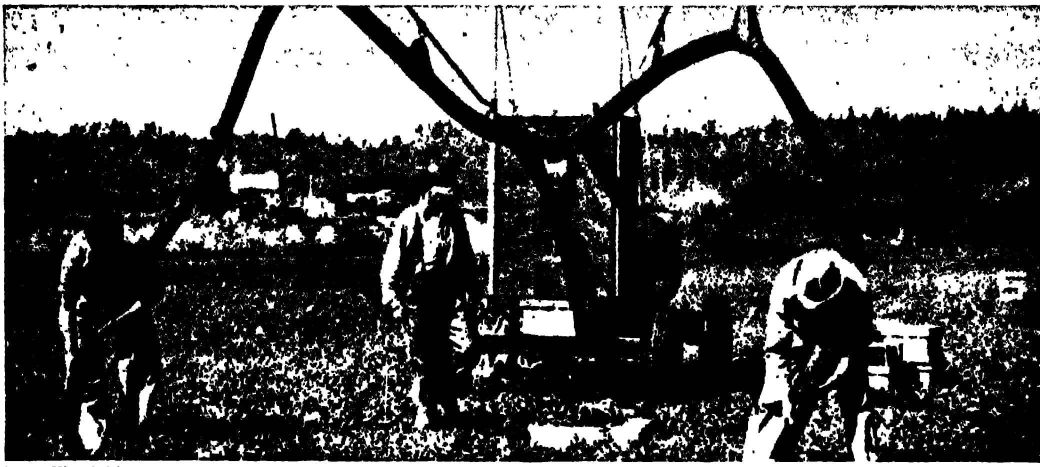
IF A botanist told you that a strawberry was not a berry but that a banana was, you would probably feel that something had gone wrong with his science. Yet he would be quite right—which only means that a "berry" is one thing to a scientist and quite another thing to the man in the street.

If you want to know the technical definition of a berry, you have only to turn to our article on fruits. Of course we most of us use the word to describe certain small fruits that are good to eat, whether they happen to be real botanical berries or not. Let us see what the chief of these are:

Berries	*Type of Fruit*
Strawberry	The dry fruit, consisting of the seeds, on a fleshy "receptacle" which is the real berry.
Raspberry and Blackberry	A collection of juicy "drupes"
Currant and Gooseberry	Both true berries
Cranberry	A true berry
Blueberry	A true berry
Huckleberry	A true fleshy drupe

For thousands of years before our modern strawberry was developed, there had been wild strawberry plants in Europe, producing rather poor, very seedy fruits. As we know it, the strawberry did not exist until some time after the discovery of America. That discovery changed the history of many garden plants, and of these not one was changed so much for the better as the strawberry.

All that Europe had known as strawberries before this had been the wild fruit of a single species, so little valued that people hardly bothered to cultivate it. But in the New World two entirely new wild strawberries were discovered. As they were first cultivated, their fruits were not much different



Wide World Photo

Machines are beginning to replace the fingers of pickers in our cranberry bogs. The one shown above literally sucks the bright red berries from the low vines on which they grow. Cranberries, which we never see until late in the fall, grow in a low, level field which can be flooded when there is any danger of frost.

from the old European sort. Of course they were sweet just as the wild strawberry of our thickets is sweet to-day, but as commercial fruits none of them amounted to anything until the plant breeders began crossing the American kinds with the European plant. From those first crosses have come the hundreds of varieties we know to-day. None of these are over a hundred years old, and the fine berries of our markets are much younger than this.

Strawberry plants are low herbs which mostly reproduce by "runners." These are vinelike extensions of the stem which easily take root at the joints, and so form new plants. This makes propagation easy for the grower, but it also makes it hard for him to cultivate the fields, since they soon become a tangled mass of strawberry plants. To avoid this difficulty the growers soon began to cut off the runners between the rows of plants, so that their weeding machines could keep the fields clean. But that left so much earth uncovered that every rainstorm spattered up enough dirt to ruin the fruit. To stop this, they began putting straw between

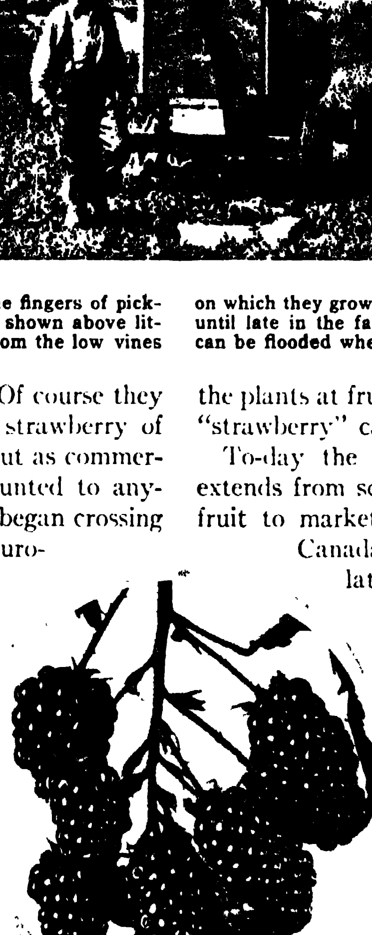


Photo by U. S. Dept. of Agriculture

There is no need to tell you that these berries, which have such glistening black coats, are blackberries.

the plants at fruiting time. And so the word "strawberry" came about, many years ago.

To-day the cultivation of these berries extends from southern Florida, which sends fruit to market in December, to Southern Canada, where the berries ripen in late July. From July to December the growers have to depend upon the so-called "everbearing" strawberry, which the breeders have taught to flower and fruit out of its regular season. But the plants that do this seem to object to the change, so from August to December our markets have pretty slender crops of the fruit.

Growing strawberries is an immense business, for it takes a great many acres to raise the enormous quantities of the fruit that we consume every year. Some of these berries have to travel two thousand or three thousand miles before we get them, and special fast trains of refrigerated and ventilated cars must be used to keep the very perishable fruit from spoiling. No other berry crop is so important, and the railroads make every possible provision for handling it rapidly and efficiently as it ripens in the various sections.

Courtesy New Jersey Department of Agriculture

When the wild blueberry bush bearing tiny, hard fruit is cultivated and properly fertilized, it rewards us with a great quantity of tender berries as large as the ones on the bushes in the picture above.

Strange as it may seem, the strawberry, blackberry, and raspberry are all closely related, and they all belong to the same family as the rose. Blackberry and raspberry bushes remind us of rose bushes in a number of ways; and so many of them have thorns that the fruit growers often call these berries "bramble fruits"—for "bramble" is an old word meaning "thorny bush." Most of them, especially the blackberries, grow on bushes so rank and thorny that for years the plants were considered troublesome weeds.

Of all the berries these bramble fruits have the youngest history; before the Revolution they were almost unknown in the garden. But to-day the blackberry and raspberry crops cover a great many acres. Of the many millions of quarts that they produce, the larger part are raspberries.

Just as with the strawberry, the modern blackberry and raspberry are a product of the skill of the plant breeder In about 1800, growers began crossing the different brambles, and from these crosses have come hundreds of different varieties of berries.

Much more recently (1881) Judge Logan of California found in his garden a dewberry, which is a prostrate, creeping sort of blackberry growing wild in the Pacific states. From that plant, either by crossing or as a sport, came an entirely new kind of berry, which came to be called the loganberry. It combines some of the qualities of both a raspberry and a blackberry, and is grown to-day on a large scale. Other recent offspring of the bramble family are the boysenberry and the youngberry.

Both currants and gooseberries were developed in Europe and well known long before the discovery of America. They are

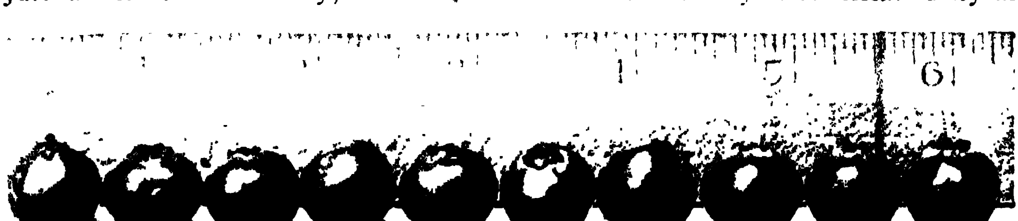


Photo by Crestview, Florida, C. of C.

A six-inch rule has been placed behind these cultivated blueberries to convince you of their enormous size.

still more prized abroad than here; there are only a few thousand acres of currants in America, and the crop they yield is a small one in comparison with other berries.

The best-known currant is the common red variety that we see in the markets. This grows on a small bush with yellowish flowers, and unlike the strawberry, the shrubs bear large crops of fruit for many years. The bushes are easily grown, usually in long rows, and picking the fruit is much easier than stooping for strawberries or fighting prickles for blackberries.

The black currant and the gooseberry, which has a somewhat bristly fruit, are little grown in America, though they are prized in England. Both currants and gooseberries harbor a pest that destroys certain pines.

Nearly all the berries in our markets have come into being after many years of careful plant breeding. They are mostly a result of crossing, and are always cultivated on berry farms. But both blueberries and huckleberries are still collected in large quantities from the wild bushes that bear them.

Many people mistake a blueberry for a huckleberry. But blueberries are true berries, usually with a bluish bloom, and have many very small seeds. Huckleberries, on the other hand, are true "drupes," always shiny black as they appear in the market, and inside them are ten small nutlets. Our article on fruits will tell you what a drupe is. Blueberries are much juicier than huckleberries, and are sweeter and more finely flavored.

Quite recently the scientists have started a new blueberry industry. They began it by offering a reward for any wild blueberry that would not go through a hole, of a given size, which they had made in a board. They made these holes much larger than the diameter of common wild fruits, and so they strained out millions of wild fruits, keeping only those too large to go through the hole. From these, by careful selection and growth, they have developed a race of blueberries nearly three quarters of an inch in diameter. Growing these improved blueberry crops is a vigorous industry, though one plant of the new sort still costs a great deal more than a wild blueberry bush. But it is worth the price, for it will produce the largest blueberries in America.

Closely related to the blueberry and huckleberry is the cranberry, though its sharp, bright fruit looks quite different from the others—as everyone finds out at Thanksgiving. It has such a distinctive way of growing that cranberry plantations look like nothing else.

The plant is a prostrate vine which will thrive only in wet, acid soil. It is usually planted in mossy bogs, where the plants completely cover the bogs. Because the red, acid fruit ripens late, the cranberry is often caught by late frosts. This would not matter if the berries were never harvested, but it spoils them for the market. To keep frost from ruining the fruit a cranberry grower arranges his plantation so that it can be flooded whenever hard frosts put the berries in danger. Afterwards the water is run off and the fruit allowed to ripen further. This may happen several times in a season, with the result that commercial cranberry bogs look like shallow lakes one day and green and red carpets of cranberry the next.

All the cranberries in our markets have descended from a single large-fruited kind that is native in North America. Most of the crop is now grown in New Jersey and on Long Island and Cape Cod.

Can you tell a dewberry from a blackberry? To the right is a box of dewberries just picked from the bramble.

This black, shiny fruit has the distinction of being the ancestor of the loganberry, popular with all lovers of juicy pie.

Reading Unit No. 13

OLD FRIENDS OF THE ORCHARD

Note: For basic information not found on this page, consult the general Index, Vol. 15.

For statistical and current facts, consult the Richards Year Book Index.

Interesting Facts Explained

How apples came to America, 9–161-62
How apple orchards are managed, 9–163-64
Cherries, 9–164-66
Where prunes come from, 9–166
The pear, 9–166-67
Peaches, 9–168
California grapes, 9–168

Things to Think About

Why can a great many kinds of fruit be grown in the United States?
What valuable minerals occur in apple skins?
What do apple growers do to get a large apple crop?
Why is California famous for her fruits?
Why are peaches expensive?
What improvements would you try to make in fruit if you were a plant breeder?

Picture Hunt

What may each apple blossom become later? 9–162
What is the best way to get apples off a tree? 9–164
Why is a tractor needed in orchards? 9–165
How old are some grapevines? 9–165
How are raisins made in California? 9–167

Related Material

What was the life work of Luther Burbank? 13–416-17
How does an apple form from a flower? 2–115
What is a "pome"? 2–121
What are "drupes"? 2–121
Why do we see so many insects, such as bees, in an orchard? 2–107-13

Leisure-time Activities

PROJECT NO. 1: Visit an orchard in different seasons, especially at harvest time, 9–164.
PROJECT NO. 2: Write for free price lists of pamphlets on fruit growing and farming in general. Address the United States Department of Agriculture, or Superintendent of Documents, Washington, D. C.

Summary Statement

Apple blossoms turn into apples of many different kinds depending on which variety was planted. Discarded apples make good cider, and from cider we get vinegar. Many fruits are dried: such as the apple, pear, peach, grape, and plum. The dried grape is a raisin, and prunes are dried plums.

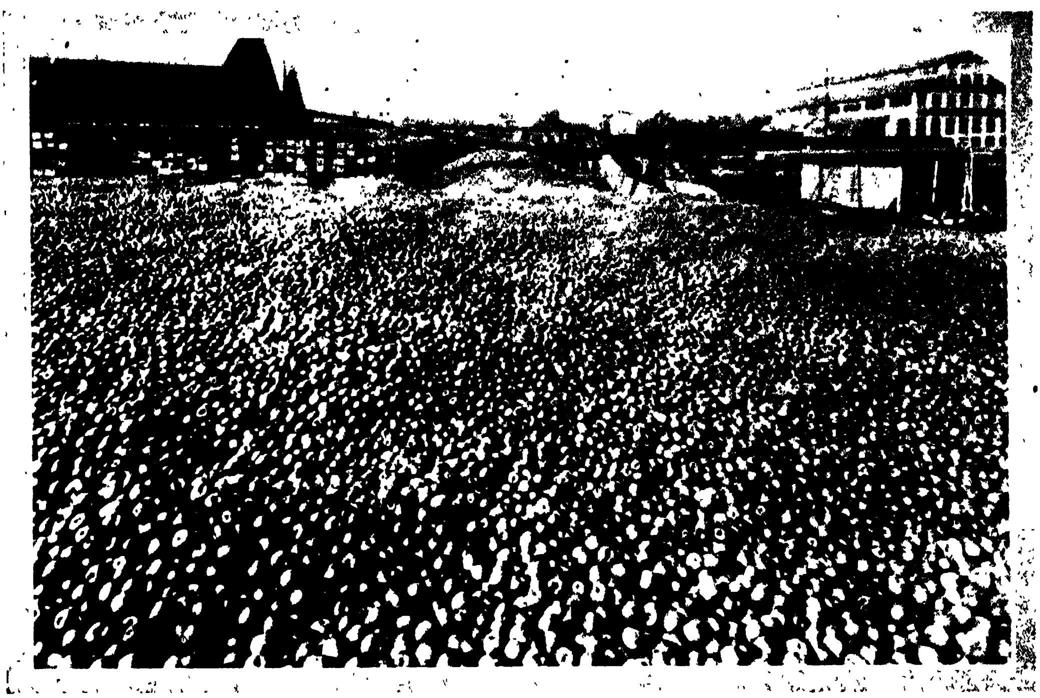


Photo by Virginia State C. of C

What happens to the tons of juicy apples that are not perfect enough for shipping? They are sent to the cider press—scratches, spots, and all—to have the delicious juice pressed out to make cider. That is what will happen to all these tons of apples at Winchester, Virginia. And from the cider we get vinegar.

OLD FRIENDS *of the* ORCHARD

How Man Has Turned the Crabbed Little Fruits That First Grew Wild into Our Luscious Apples, Peaches, Pears, Plums, and Grapes

WHEN the serpent tempted Eve he did it with an apple. He did not choose an orange, a peach, or a banana, popular as those fruits are with us to-day. He offered a taste of our good old friend of the orchard. Now besides telling us a great deal about the nature of men and women, and about one of the causes of evil in the world, this Bible story reveals some interesting things as to the diet of the early Hebrews. Clearly, they must have regarded fruit as one of their great delicacies; and of all the fruits they knew, they must have liked the apple best.

There would seem to have been a good many other ancient peoples who felt about the same way, for since the beginning of time the apple and the grape have been the fruits that poets have sung most lovingly. Of the many fruits that grow, they seem to lie nearest the hearts of men. And in spite of the competition the apple has had to meet from newer and more luscious fruits, such as the orange, the good old stand-by still remains so popular that apple growing is the largest of all fruit industries in the United States.

Not one of our commonest American fruits had its origin in this country. All of them—the apple, the plum, the pear, the peach, and the cherry—were eaten by men for many centuries before America was discovered. Their first homes were in Europe and Asia, and when the early English and Dutch settlers brought them to this continent, count-

Photo by Canadian Pacific Ry.

Man and Nature may feel well rewarded for all their years of patient toil when they see an apple orchard in full bloom. It is a great temptation to pick whole armfuls of these fragrant coral-edged blossoms; but one must remember that each delicate flower gives promise of becoming a luscious fruit.

less gardeners all over the world had already been at work on them for centuries to make them bigger and sweeter. Yet since they were first brought over, they have been so much improved that scarcely a variety grown here before the Revolution is raised in this country to-day. From those early importations hundreds of American varieties have been produced, until our fruit industry is now worth hundreds of millions of dollars a year to the growers.

A Land of Orchards

Luckily for us, those Old World fruits took to the life in their new home. Every condition necessary for fruit raising can be found somewhere or other in this vast land. America has dozens of different climates, and every sort of soil. As a result, we have been able to improve the common fruits more than they have been improved in any other country. Our great regions for raising them are in the northeastern states and along the Pacific. Of course fruit will grow in many other sections; a good deal of it is raised in the Ozark country, for instance. But in general, the prairie states grow better wheat and corn than they do fruits Our greatest states for common fruits are Washington, Oregon, and above all, California.

A well-known lecturer is very fond of telling his audiences that since boys and girls need more iron in their systems, what they should all do is to peel an apple, eat the peelings, and throw the rest away. No one pays much attention to him, but he happens to be right, just the same! For though we do not eat apples just for their iron, it is true that their skins do contain more iron than is found in almost any other fruit. Of

course, the juicy red fruit contains many other valuable properties. And luckily there are enough apples raised to go around, in this country at least; for though the apple is very obliging, and will grow almost anywhere in the world, the United States, with its bright sun and warm summer weather, produces more apples than any other country. We harvest hundreds of millions of bushels a year. Of these a great many are eaten fresh, but many tons of them go to the making of dried or "evaporated" apples, and perhaps even more are used to make cider.

Most of the smooth, rosy-cheeked apples that we eat are the result of highly organized fruit farming. Magnificent apples with a fine flavor are raised in New York State, but certainly the greatest orchards are to be found along the Columbia River in the state of Washington. There, in the vicinity of the town of Wenatchee, the business of raising apples has been more highly developed than anywhere else in the world.

A Festival of Apple Blossoms

To stand on the rim of this valley in early May and look down on the apple orchards around Wenatchee is a delightful experience. As far as the eye can see are sheets of pink and white blossoms. Every spring the people who live in the region hold a festival of apple blossoms, with parades and pageants and other jollifications. And well they may, for those waving billows of pink and white will produce a crop worth millions of dollars to that valley alone.

Now the amazing part of it all is that the hills and valleys around Wenatchee, if left to themselves, would be almost a desert. All that would grow there would be a few stunted pines, some badly burned grass, and a handful of miserable shrubs. Yet from this valley and others like it, apple growers have made fortunes. How, you say? Simply by the exercise of skill and patience. Nature has provided the sunshine which apples need at ripening time to bring out their fine color, but has denied the water that is so necessary to make the trees thrive. But here skill and patience have stepped in. The whole region is irrigated by an elaborate system of canals, ditches, and pipes that give every orchard just the amount of water it needs in the course of the season.

A Modern Orchard

Some four or five times a season the growers water the trees plentifully. Between waterings they keep the ground thoroughly cultivated, in this way making a "dust mulch," which stops the water from evaporating too rapidly from the soil. You may read all about this method of "dry farming" in our story of the long growth of agriculture.

But irrigation isn't all! The people of Wenatchee have given such patience and skill to the business of growing apples that their methods have been copied in other apple regions all over the world. At every step they have brought the utmost of scientific knowledge to bear upon their problem. Nothing is left to chance. Frosts are guarded against by the installation of smudges

This is perhaps the only monument ever erected to an apple! If you read the inscription you will see that as much importance has been attached to the "invention" of the "Delicious" apple as to a scientific discovery.

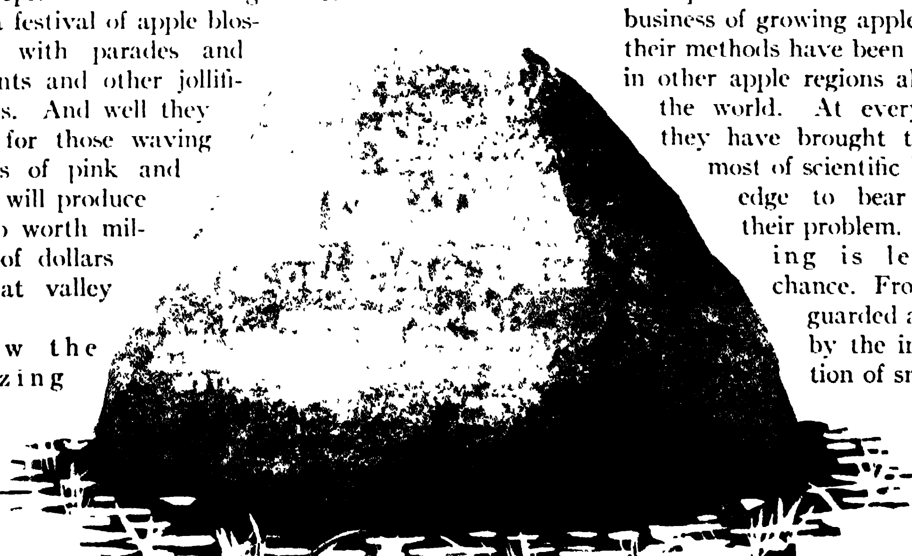


Photo by Iowa State Dept of Agriculture

Courtesy U S.D A. photo by Ackerman

It is in Utah that these orchard workers are weighing in their baskets of cherries. Fine fruit of many kinds is grown in the fertile soil of the western deserts once water is brought in by modern methods of irrigation.

and oil heaters. Diseases and insect pests are fought by the most scientific and elaborate system for spraying in the world. Sometimes the air will be blue with thousands of gallons of insecticide, which is released in clouds by power sprayers until it covers every part of the orchards.

The Finest Apples in the World

No grower is allowed to neglect these operations, and few would want to do so, for everyone in the region knows that the result of such neglect will be—just ordinary apples. And of course no one living in this beautiful valley would want to produce ordinary apples. Every year the people of Wenatchee send away many thousands of refrigerator cars loaded with the most finely colored and the most carefully graded apples in the world. When they reach the markets in London or New York they are still in perfect condition.

Not many of us will ever visit a great apple or orange orchard, to pick the choice fruit ripe from the tree, but nearly all of us have at some time or other been able to climb a plum or cherry tree and to learn how much more delicious the fruit tastes when you pick it yourself from the bough. Those two homelike fruits will grow in any back yard where the winters are not too bitter. They are first cousins to each other, and both are descended from far-off wild ancestors in Eastern Europe and Western Asia. Those wild forebears were not very different from each other, and to-day their hundreds of cultivated descendants have flowers that are a good deal alike, and all bear a fruit with a single stone.

How We Change Our Fruits

The character of that fruit has been changed by plant breeders, very much for the better. Plums, for instance, have been dressed out in skins of purple, yellow, green, and black; and a whole group of them has

OLD FRIENDS OF THE ORCHARD

Photo by Caterpillar Tractor Co.

This "caterpillar" is not harmful to the fruit industry, for the modern "prune" farmer can use the same tractor to cultivate his plum trees and to haul the day's pickings from orchard to packing house.

Photo by H. E. Zimmerman

Long ago, in the 18th century, this marvelous grape-vine was planted at Hampton Court, near London. To-day thousands of visitors go to see it laden with its 2,000 clusters, which average weighing 2 lbs. each.

been developed for no other purpose than to be dried and sold as the familiar prune.

Cherries, too, have been bred for two quite opposite traits; we have the sweet and the sour. The sweet, which have taken on a variety of complexions, we eat raw; but the sour red cherries are highly prized for making preserves and cherry pies. Both cherries and plums contain a refreshing acid that forms a useful part of the diet of nearly all civilized people.

America has many native kinds of wild plums and cherries, but hardly one of them has produced modern varieties of importance. It is from European and Asiatic trees that we have developed the hundreds of kinds that make plum and cherry growing a successful business, especially on the Pacific coast. Millions of plum trees bloom every year in southern Oregon and along the coast of California.

Where Prunes Come From

Most of the California plums come to our breakfast tables in the shape of prunes. Now is true that many people who ought to know better make fun of the simple prune, that loyal friend of our childhood. But no one who understands what a valuable food the prune is can ever laugh at it again. Of course, it is nothing more nor less than a very luscious plum that has proved itself unusually valiant in withstanding the test of being cured and dried. It is always picked ripe; and while fresh plums must be handled as carefully as strawberries to keep them from spoiling, the prune, largely by reason of its training at the hands of Luther Burbank, will travel thousands of miles and appear on our tables at any time of the year. No wonder that thousands of tons of this accomplished plum are sold every year.

How Nature Smiled on California

California also grows more cherries than any other state in the Union. Indeed, no other state can equal her in the production of fruits of every kind. Her total fruit crop is worth many millions of dollars yearly. Part of this success is due to the kindness of Nature in giving the state a mild climate and plenty of sunshine, but part of it is due to the application of scientific methods taught to the fruit growers by the agricultural experiment station.

The pear is so closely related to the apple that botanists call them first cousins. They differ, of course, in shape and flavor, and also in the fact that the pear has "grit cells" scattered through its flesh. Like the apple, it has a long and honorable history. Fifteen hundred years before Christ it was well known in Greece, and no one knows how long it had been eaten in China before that. Its seeds have been found in the Swiss lake dwellings, where people lived as much as ten thousand years ago.

Nowadays some five thousand varieties are grown—largely in Europe, where the climate and soil are just right and the fruit

If it is a good "peach year" you will find the markets flooded with baskets of pink-cheeked beauties like these.

Photo by North Carolina State College

Photo by Fresno C. of C.

There is no rain in central California between April and September. So the grapes which have been picked are laid out in rows, between the long lines of grapevines, to be dried into raisins by the hot sun. It will beat down upon them with no danger of interruption from a sudden rainstorm.

Photo by Fresno C. of C.

No artist's horn of plenty could be more weighted down with gorgeous fruit than are these grapevines, covered with heavy clusters of the seedless grapes which are grown for the raisin market.

is greatly liked. France and Belgium raise the best pears, often by training the branches to grow against a wall with a warm southern exposure. California is by all odds the best of our states for growing this fruit.

For many centuries before the birth of Christ the people of China were cultivating the peach, which probably was found wild in their land. It did not make its way to the West for a long time; it is not mentioned in the Bible, nor was it known to the early Greeks. But the Persians learned of it and perhaps it was from them that the Europeans finally got it.

What Is a Peach?

Once having tasted it, everyone loved the "plum with a fuzzy coat"—for that is what a peach really is. It is a close relative of the almond, and so close to the smooth-skinned nectarine that nectarines and peaches may sometimes be found growing on the same branch, and the seeds of one may sometimes produce trees that bear the fruit of the other.

We have the Spaniards to thank for having brought the peach to America. With the help of the Indians they spread it over Mexico and what is now the southwestern part of the United States. Much later people began to plant it in Georgia, Delaware, Maryland, New York, and New Jersey, and to-day millions of peach trees bloom in those states every year.

We say that they bloom every year. Whether or not they bear fruit is an entirely different matter, for raising peaches is the greatest risk in the fruit industry. In the first place, no really good variety of peach has ever been taught to stand hard frost while in bloom or just after the blooming period. Since peaches bloom early, from ten days to two weeks earlier than apples, the blossoms are often nipped. Besides this, the trees are subject to a number of diseases, and are short-lived. Most growers cut them down at the end of fifteen years. And last of all, ripe peaches spoil very quickly and so are very difficult to market.

For all these reasons the peach farmer may meet disaster, and must have a good price for his crop. On the other hand when the season is just right and the price favorable he can get a handsome return. Of course the great canning industry often comes to his rescue. If he cannot market his peaches at the moment when they are ripe, he can easily send them to the canning factory, In California, where peaches are grown on a large scale, nearly all the crop is canned, or evaporated to make "dried peaches." The same thing happens to the apricot, a close relative of the peach.

If you have read all we have just said about our common fruits, you will not be surprised to learn that California is the greatest fruit-producing area in the world, and that among us she has something like a monopoly of the sixth and last of our common fruits. This is the grape, so old a friend to man that its familiar seeds have been found in the tombs of the ancient Egyptians. There are many kinds of wild grape in the United States, and from some of them good cultivated varieties, like the Concord, have been developed. Other wild kinds have given rise to modern varieties used only in the making of grape juice. These are grown along Lake Erie and in various localities in the eastern states. But altogether only a fraction of the grapes grown in our country come from the East. The rest are all raised in California, and are descended from Old World varieties.

The Grape That Gives Us Raisins

The California grape may be eaten in two very different forms. First, the state raises the beautiful green and yellowish-green table grapes that come packed in sawdust and are usually quite expensive. They are sweet and tender, and are eaten skin and all. Then it raises the kinds that can be dried into raisins. Thousands of acres are planted to these varieties, and thousands of tons of raisins are grown every year. But the largest crop of all consists of the grapes used to make wine.

Large portions of California are nothing but vineyard, covered with the woody vines that the growers keep short and will scarcely allow to trail at all, even on trellises. These little vines produce huge crops that bring in hundreds of thousands of dollars a year.

Reading Unit
No. 14

A FAMOUS FAMILY OF FRUITS

Note: For basic information not found on this page, consult the general Index, Vol. 15. *For statistical and current facts, consult the Richards Year Book Index.*

Interesting Facts Explained

Why no citrus fruits may be taken into California, 9–170-72

Where citrus fruits came from, 9–172

Why the first oranges were unfit to eat, 9–172

How sweet oranges came to Europe, 9–172-73

How oranges are raised and harvested in California, 9–173-75

The origin of the seedless, or navel, orange, 9–175

How lemons saved sailors, 9–175

Things to Think About

How are insect pests kept out of a state?

What was the home of the first sweet orange?

How are orange trees protected from frosts?

How are seedless oranges produced?

What do you consider the most useful fruit?

Picture Hunt

How are oranges harvested? 9–170

Did civilization always have sweet oranges? 9–171

In what ways do orange pickers have to be careful? 9–172

How can a grapefruit branch bear the great weight of its fruit? 9–173

What is meant by "grading" oranges? 9–174

Related Material

How is land irrigated? 10–539-44

What is meant by "plant quarantines"? 2–141

What did Captain Cook's great voyage contribute to mankind? 2–363-64

What does a navel orange look like? 2–230

How is one plant grafted on another? 2–231

Leisure-time Activities

PROJECT NO. 1: Make candied orange peel, 14–84.

PROJECT NO. 2: Make lemonade and limeade, 14–88.

PROJECT NO. 3: Make a fruit punch for a party, 14–88.

Summary Statement

The citrus fruits include oranges, lemons, grapefruits, and limes. Sweet oranges grow on trees with poor roots; therefore the branches of sweet orange trees are grafted on the branches of a rooted tree which normally would produce small, stringy, and bitter oranges. In this way we can always produce fine oranges without planting their seeds.

Photo by Union Pacific Ry.

There are few things in the world more beautiful than an orange grove, whether the trees are covered with perfumed blossoms or heavy with ripening fruit. Here winter and summer are not far apart, for the orange trees bask in the warmth of a sunlit valley, to the right is a stately palm, and in the background, rising like a rugged protective screen, are the snow-peaked mountains of California.

A FAMOUS FAMILY *of* FRUITS

About the Golden Spheres That Are the Ornament of Every Breakfast Table and the Backbone of a Famous Summer Drink

ALL along the borders of California, wherever a road or railway crosses the boundary line, there are groups of uniformed officials who examine the baggage on every train and every automobile coming into the state. No one may pass them without a thorough inspection. This has nothing to do with contagious diseases, nor yet with the detection of crime. The officers are looking for what would seem to be about the most harmless things a traveler can carry—they are looking for oranges and lemons. Whenever they find one—and whenever they come on a grapefruit or lime, a kumquat or tangerine—they seize it at once and burn it, for no one may bring into the state any fruit belonging to the citrus (sĭt'rŭs) family.

Now why, one naturally asks, does the state go to all this expense? What could be the harm of admitting a few oranges and lemons? The answer lies in the fact that the sale of those fruits amounts to millions of dollars a year in California; only the petroleum industry overtops it in size. Nat-

Photo by Florida Citrus Ass'n

This fine orange tree which grows in Florida is the result of many years of patient breeding. Florida oranges are very juicy, and the state does a big business in selling the juice in concentrated form.

urally the people of the state wish to do everything in their power to protect so great an industry.

And what do they protect it from? From an innocent-looking little fly that a few years ago was accidentally brought to Florida from the Mediterranean. It at once set about its deadly work of destroying the orange crop. with the result that many growers were ruined and a number of banks were wrecked.

No wonder the people of California are doing everything in their power to keep the terrible immigrant out of their state. They are trying to protect an industry that raises roughly a half of the oranges and practically all the lemons used in the United States.

In spite of the fact that we grow so many citrus fruits, not one of them is a native of the New World. Some of them, like the orange, have been known for two thousand years in India. In fact, most scientists think that it was in India or Southern China that the orange, and perhaps all the citrus tribe of fruits, had their wild home.

Photo by California F

Above, you see the picker transferring the oranges which are in his picking bag to an orange crate. In the circle is a "close-up" of the picker's hands, showing how he measures the oranges for size with a measuring ring. You will notice that in both pictures he is wearing gloves.

But it did not take the Spaniards and Portuguese long to bring the citrus fruits to the New World, after they had discovered it. Once here, those delightful visitors from the Orient turned to and conquered the hemisphere on their own account. In a short time they had escaped from the gardens in which they had been planted and were making themselves at home in the wilds of both North and South America. Their seeds were carried by birds to the most distant jungles, and there one may find the trees growing to-day.

Now of course those wild orange trees took not the slightest interest in making their fruits delicious to man. Their whole effort was to adapt themselves to the new soil and climate. Their fruit was sour and stringy, and so people thought that sour and stringy was what an orange must always be. No one knew that it could be made into one of the most delicious of Nature's gifts to man. So the result of this first transplanting of oranges to the New World was to retard the development of the citrus industry by many years.

For all fine oranges, lemons, and grapefruit are the result of long and patient selection by the plant breeders. Few of them are raised from seed, and almost none are grown on their own roots. The varieties with the best fruits often have poor or tender roots, and must always be budded or grafted on stout stocks which would otherwise have small, sour, stringy fruit.

Oranges were well known in India and tropical China long before the Christian era, but these regions were so remote that they were rarely visited by travelers from the West, and were never reached by sea until after the discovery of America. Oranges, then, were unknown to most Europeans for the first thousand years after Christ. But in the ninth century some Arabs traveling by caravan from the East brought the first orange to Constantinople.

No one cared much for the new fruit, for the Arabs had brought samples of the bitter orange only. They did not know that there were two kinds, the bitter orange, now used mostly to make marmalade, and the sweet orange, which is the ordinary orange sold in the markets. For two or three hundred years Europe had only bitter oranges—all because of that mistake of the Arabs. The fruit was mostly grown in Spain, in the neighborhood of Seville, and so it came to be called the Seville orange. That is still the name for the bitter orange in England, where it is used by the million every year to make that attendant upon every English breakfast—orange marmalade.

Some time late in the fifteenth century Portuguese seamen brought the first sweet

orange from India or China to Europe—probably to Italy or Spain. From that almost chance introduction, orange raising has grown to be an immense business in Spain, where millions of boxes are harvested every year. Only the United States exceeds this huge output.

What Is the "Florida Orange"?

It is said that the gallant Ponce de Leon (pōn′thā dā lā-ōn′) first brought the orange to the United States when he landed in Florida (1513) in his search for the Fountain of Youth. Certainly it could not have been started here very much later, for when the early settlers came (1565) they found plenty of citrus fruits of all sorts growing wild in Florida. From those wild groves the so-called "Florida orange" of to-day is largely descended. It is really a Spanish orange, very juicy, sweet, winy, and covered with a thin tight smooth skin. It differs from the navel orange in flavor and in the fact that it has kept some of its seeds. Navel oranges are grown very little in Florida. They do not bear well there.

Though Florida started raising citrus fruits some two centuries before California, the western state for a long time took the lead. Florida growers had bad luck. Most of their groves were killed by frost in 1895, and many were lost in later freezes. Besides, they were visited by pests, especially the dreaded Mediterranean fruit fly. But the growers did not give up. They had skill and patience and enterprise, and finally during World War II they exceeded the California output by a wide margin. The two states will doubtless run neck and neck for many years. Other states too are planting citrus groves. All of the regions along the Gulf of Mexico can raise the hardier varieties, and Arizona by the use of irrigation has developed a great many excellent groves.

Unusual Citrus Fruits

Florida has always been the state to raise the rarer citrus fruits. There the grapefruit was first marketed around 1900—though the Spaniards had imported it nearly four centuries earlier. To-day it is one of Florida's most profitable crops.

That delightful, spicy little fruit known as the tangerine first arrived in the New World at New Orleans around the middle of the last century. But eventually it made its way to Florida, was developed there, and now is grown there in large quantities. It too came originally from Southeastern Asia. Often it is referred to by the older name of "mandarin," and in that case the name "tangerine" is reserved for a variety of mandarin known as the Dancy. But if there ever was a real distinction between the two varieties it has long been wiped out. The tangerine is the hardiest of all the citrus tribe, and grows in many orchards in Texas and along the Gulf.

Like oranges and lemons, limes were first brought to Florida by the early Spaniards, but until lately we got most of our supply from the West Indies. Now Florida grows them abundantly on the warm sandy keys. They are closely related to lemons but tend to run smaller and often have a bright green skin. They are coming into wide use.

The Tiniest of Citrus Fruits

The dainty kumquat (kŭm′kwŏt), smallest of the citrus tribe, made its way here from China around 1850 and is grown in many parts of Florida, for it is very hardy. The fruits are borne on a bush, and are mostly used for making preserves, though the raw fruit, eaten skin and all, is delicious.

There are still other members of the citrus family that are never seen in the market. One is the shaddock, which takes its name from a Captain Shaddock who sometime before 1707 brought the seeds to the island of Barbados. The fruit, which is somewhat like a grapefruit, is bitter, coarse, and sour. A single fruit will sometimes weigh as much as fifteen or twenty pounds. Often the flesh is pink, as is the flesh of some grapefruit and of a delicious orange called the blood orange.

In Italy is an orange tree that is over seventy feet high. In California the trees are not allowed to grow much over twenty feet high. They are set out in even

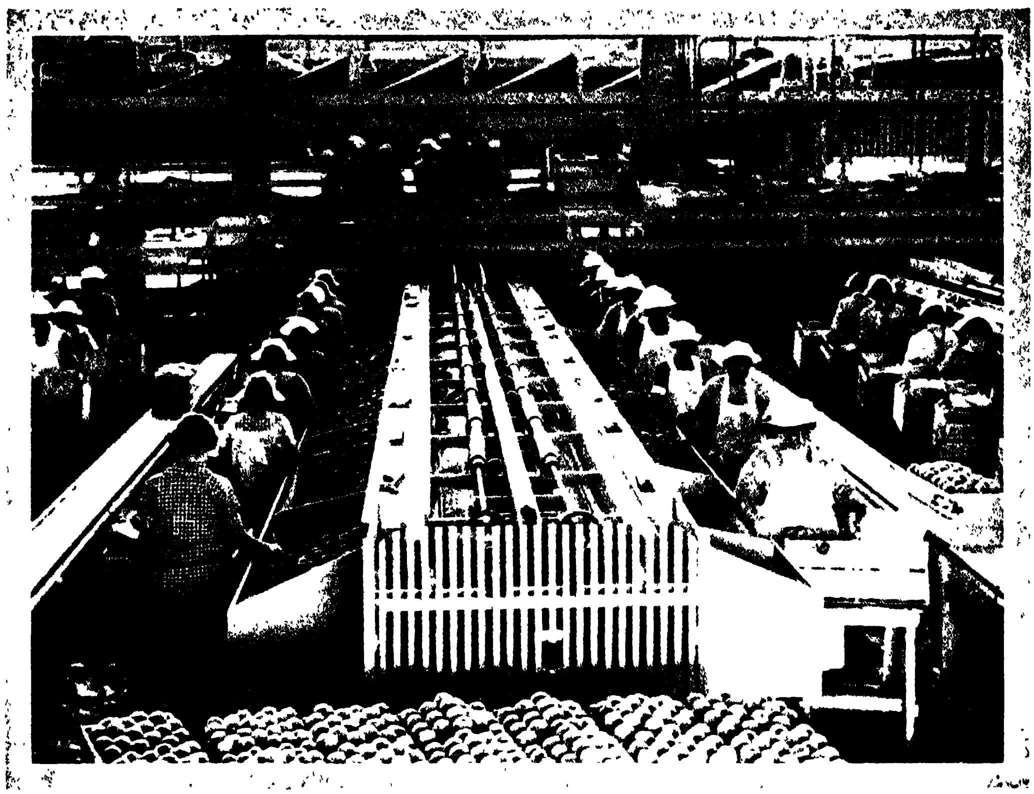


Photo by California Fruit Growers' Ass'n

Did you know that most of the oranges you buy passed through many white-gloved hands before they came to you? The picture above shows the process of sorting in an orange factory. A tramway carries the fruit past rows of workers who separate the bruised and inferior oranges from the better grades. Then the fruit is measured in a "sizing" machine. Finally it is packed in crates according to size and grade.

rows, which are sometimes miles long. Tremendous power cultivators keep the ground between the trees cultivated and free from weeds.

One of the most interesting sights in an American orange grove may be seen only in winter. The orange is not a strictly tropical crop, and will even stand a slight frost. But it will not stand a heavy one, such as may on rare occasions visit any part of the United States. Such frosts in the old days killed thousands of citrus trees in both California and Florida. But that does not happen any more. The growers have an elaborate equipment of oil stoves and smudge pots set all through the plantations. Whenever the weather man tells them that there is danger of frost, gangs of men start these little furnaces going. Fire is kept in them all night to take the edge off the nipping air, for the smudge keeps the heat from rising. The cost of such fires is considerable, but without them the growers would sometimes lose many, many thousands of dollars.

Orange-blossom time is a period of pure enchantment. No fruit blossom can compare with the orange in fragrance; and even the foliage of the tree is aromatic. But the growers see that few blossoms are picked, because fruit will follow soon if the trees have proper care.

Part of that care is to see that the trees get enough water. California has plenty of heat and sunshine, for in the orange regions there are almost 320 clear days a year. But the state has a very poor rainfall. To overcome this all California orange groves are irrigated; otherwise they would not produce good, juicy fruit.

In the north no one ever eats a fresh, tree-ripened orange. Such a fruit spoils so quickly that the growers do not dare to let the pick-

ing wait until the oranges are perfectly ripe. The fruit that is shipped has always been picked when it was still quite green. All the picking is done by hand, and with the greatest care. Each picker carries a small bag, which holds only a few oranges; in this way the fruit is never crowded together as it is picked. Wagons cart the freshly-picked oranges to the huge packing shed, where hundreds of girls begin the work that ends only when the fruit reaches you in the market.

First the oranges are sorted as to size. Each grade then goes on long, power-driven racks to another group of girls. Every fruit with even a faint scratch is picked out of the lot. Then the perfect ones are wrapped in tissue paper and packed in the boxes you see in the market.

If you should ever land on the water front of Bahia (ba-e′a), Brazil, a dozen old women will at once try to sell you what are the finest oranges in the world. That wonderful old city, once the capital of Brazil, seems always to have been noted for its oranges as well as for its three hundred and more churches and for the beauty of its cloister gardens.

An Orange without Seeds

Somewhere about 1600, quite by accident and as a pure "sport," an orange tree in Bahia produced fruit with no seeds. It was a splendid orange, juicy, sweet, and of the finest flavor. Instead of seeds it had a curious growth at one end, just under the skin, it was a pure freak. That freak was the "navel" or seedless orange, and a few plants of it were first brought to the United States around 1870.

The Bahia orange made the citrus industry a great business in America. No sport in the horticultural world has ever been so valuable as the navel orange, hidden away in that Brazilian city of churches for over two hundred years. Of course it has always been propagated only by cuttings or grafting, as it never has any seeds.

Lemons have been cultivated far longer than oranges in Europe. They first came from India, but in 1492 they were so common around the Mediterranean and in the Azores that there was already a large trade in them to England.

In those days no one had ever heard of vitamins, but everyone knew that English sailors were always getting scurvy, a disease almost unknown to-day but for many years the seaman's scourge. It was caused by a diet in which there were too few vitamins, and it was soon found that sucking lemons cured or prevented it.

How Lemons Serve the Sailors

For years after this fact was discovered every English ship was forced to carry enough lemons so that every sailor could have his daily ounce of lemon juice. To-day we know that all the citrus fruits are very rich in vitamins, but especially the lemon. Vitamins have no food value in themselves, but these citrus vitamins—or vitamin C—are valuable because they protect us against infections.

Nearly all the lemons in America are grown in California. The crop is nearly as valuable as the orange crop, and much less expensive to handle, for ripe lemons will keep a long time. Of course, in spite of all the lemonade drinkers and lemon-pie makers in the country, the lemon crop is very much smaller than the orange crop. The state does however ship some millions of boxes of lemons a year. A good many are used in California in the making of citric acid, which is used for "artificial lemonade" and in printing cotton cloth. Orange and lemon oil are also valuable.

Citric acid is found in all the citrus fruits. They may have different flavors and be as different in size as a grapefruit and a kumquat, but all of them contain some of it. The Romans knew about certain of these fruits—the lemon, perhaps the lime, but especially the citron, which is a fruit a little like a lemon but not pointed at the end. Only its aromatic rind is valuable; this is often used in making delicious confections and preserves. The Romans called it a "citrus." Hundreds of years later Linnaeus grouped together all the plants with a citric acid fruit and called it the citrus family.

Reading Unit
No. 15

CHOCOLATE AND COCOA

Note: For basic information not found on this page, consult the general Index, Vol. 15.

For statistical and current facts, consult the Richards Year Book Index.

Interesting Facts Explained

How we became acquainted with cocoa, 9–177
Where chocolate comes from, 9–177
How cacao pods provide chocolate, 9–177-78
Why chocolate has a high food value, 9–178
How cocoa is made from chocolate, 9–178

Things to Think About

Why was chocolate unknown to the first Spaniards who came to America?
How are cacao pods treated by chocolate makers?
Why are a great many cacao trees needed to supply the world's chocolate and cocoa?
Why are rich candies sometimes hard to digest?
How is chocolate turned into cocoa?
In what way is cocoa as bad as tea and coffee?
What affect does the eating of too much candy have upon the health?

Picture Hunt

Where can you find cacao trees? 9–177
In what is raw chocolate found? 9–177
Why do cacao pods grow on the tree trunk or the larger branches? 9–178

Related Material

What drug used in medicine and dentistry comes from the "cocoa" leaf? 9–217
Besides chocolate, what other gifts did we get from the Indians? 9–104, 221
What does a cacao pod look like when opened? 2–127
How did Indians flavor their chocolate? 9–207

Leisure-time Activities

PROJECT NO. 1: To make candy, see 14–84-86.

Summary Statement

Mexican Indians gave chocolate to the world. The pod of the cacao tree contains a few beans, which are dried in the sun and are then crushed to remove the cocoa butter. The chocolate that is left is called cocoa. When we add extra cocoa butter to cocoa and sugar we have chocolate.

Photo by Keystone View Co

Did you know that the chocolate you eat was once wrapped up in a pod, as a pea is? When the pods have ripened on the cacao tree, the natives pick them, using long poles to knock them down when the pods grow out of reach. The photograph above was taken in Ecuador, where the cacao tree thrives.

CHOCOLATE *and* COCOA

The Strange, Bitter "Bean" That Gives Us the Delicious Coating to Our Candies and One of Our Most Nourishing Drinks

WHEN the Spaniards first came to America they found the Indians of Mexico drinking a cold, frothy liquid so bitter and strong that the Europeans made a wry face when they tasted it. The Aztecs called it "chocolatl," and said it came from the "cacao" tree. No European had ever heard of it, for the cacao (kȧ-kā′ō) tree is found wild only in tropical America.

You have doubtless guessed already that what the Indians were drinking was cold, unsweetened chocolate. They had no sugar to sweeten it with until the Spaniards brought sugar from Europe, but they had nevertheless been drinking their "chocolatl" for hundreds of years before 1492, and knew all about the tree that gives us cocoa and chocolate to-day.

The chocolate tree, known usually as the "cacao," is found native in the warmest and wettest parts of tropical America, though to-day most of our chocolate comes from trees planted in tropical Africa. It is a small tree, bearing about six thousand flowers a year; of all these blossoms only about twenty ever produce fruit. This fruit consists of a large pod, which, strange as it may seem, is borne directly on the trunk and larger branches of the tree, never on young twigs. Even those twenty pods would not mature unless the cacao trees were grown under the shade of other larger trees. Sometimes the sheltering tree is a banana.

A cacao plantation is a busy place when the fruit is ripe. The pods, which weigh about a pound each, are picked from the trees and slashed open with a heavy knife. Inside there is a sweet watery white pulp in which are embedded the cacao beans. These rarely weigh more than a few ounces to a pod, so it takes many millions of trees to produce the half million tons of cacao beans

that are harvested every year to supply the world with cocoa and chocolate.

The beans that are hidden in these big purplish-brown pods are about the size of almonds, but not pointed at the end. As they come from the pod they are covered with the white slime of the pulp. At first they are merely stacked in heaps, where for about three days their slimy, sweet covering makes them ferment very rapidly.

This fermentation helps to cure the bean, but it also adds to its natural bitterness. After the third day the beans are spread out in the sun to dry. Sometimes you may see many tons of the cinnamon-colored seeds spread out thinly on huge pieces of canvas, but in very rainy regions the beans are dried in ovens. They must be perfectly dry before being packed in the large sacks for shipment; otherwise the whole crop would mildew long before it could reach the cocoa or chocolate factory.

You may have noticed that up to this stage we have been speaking only of "cacao," "cacao trees," and "cacao beans," and not of cocoa or chocolate, both of which are manufactured products made from the cacao bean. In the old days people thought chocolate and cocoa came from what they called the "cocoa-nut" palm. They simply mistook the Indian "cacao" for "coco," the name of a fruit which really does come from the "coconut" palm. And so the words got badly mixed in common usage

This is the way the pods grow on the cacao tree. You will notice that they are all hanging from the larger branches and the trunk of the tree, instead of from the twigs. It is just as well that this is so, for a pod usually weighs about a pound, and the smaller branches would hardly be strong enough to bear such a load.

The very bitter, dried cacao bean is covered with a more or less papery shell, which is easily crushed and blown away by fans. What remains when the shells are removed are called "cacao nibs"; they are the real raw product for the making of both chocolate and cocoa. More than half the weight of these nibs consists of "cocoa butter," a rich, oily, dark-brown fat which is one of the richest foods in the world. It is because of this richness that chocolate has such a high food value; not only does everyone with a sweet tooth like it for its delicious flavor, but soldiers and explorers rely upon it as one of the most highly concentrated foods found in the plant world.

Chocolate, in the old days, was simply the ground cacao nibs mixed with enough sugar to overcome their natural bitterness. But modern candy makers found that they needed even more cocoa butter in the mixture than is naturally found in the nib. So to-day we add to the mixture of cacao nibs and sugar a fairly large percentage of cocoa butter

It is just that extra quantity of cocoa butter that makes some candies hard to digest, they are too rich It also accounts for the very large manufacture of the ordinary cocoa that we use as a beverage. For it was soon found that if too much cocoa butter was left in chocolate that was to be used as a beverage, the drink was too rich and oily. So machines were invented to take out most of the cocoa butter, leaving the cocoa. They consist of huge heated rollers, somewhat like the rollers on a mangle in a laundry. Through this machine the nibs are forced, and from them is squeezed more than half their load of cocoa butter, or fat. Most of this, as we have seen, is added to the chocolate mixture, but a good deal is used in making cattle food, perfume, and even a medicinal oil. The cocoa that is left is high in food value, and like tea and coffee contains a powerful stimulant.

"Cocoa," then, is chocolate with most of the fat removed, while "chocolate" has an added dose of fat, rescued from the cocoa.

Reading Unit
No. 16

A FRUIT THAT MANY PEOPLE LIVE ON

Note: For basic information not found on this page, consult the general Index, Vol. 15.

For statistical and current facts, consult the Richards Year Book Index.

Interesting Facts Explained

How bananas came to the West Indies, 9-180
How the steamboat helped New Yorkers to get bananas, 9-180-81
The unusual way in which bananas are shipped, 9-181
How bananas are ripened, 9-181
The banana plant, 9-181-83
How new banana plants are obtained, 9-183
Bananas that remain green and are cooked, 9-183

Things to Think About

Why is speed so important in shipping bananas?
Why are green bananas shipped in chilled parts of a boat?
What kind of banana is cooked like our potatoes?
Do you think you would enjoy living on bananas?

Picture Hunt

Where does Manila hemp come from? 9-180
How long has mankind known the banana? 9-180
In what condition are bananas harvested? 9-182
Where are bananas ripened? 9-183

Related Material

How is rope made from Manila hemp? 9-282-86
How does Central America ship its bananas? 7-41
Where do the Banana Islands send their bananas? 7-60
How are banana stems used by some Indians in the tropics? 10-137

Leisure-time Activities

PROJECT NO. 1: To a slice of banana add some iodine. A blue-black color shows the presence of starch, 9-183.

PROJECT NO. 2: To find out if bananas have sugar, boil a small piece in Benedict's solution. A brick-red color shows the presence of a simple sugar, 9-180.

Summary Statement

Bananas are to the people in the tropics what potatoes are to us in the north. The banana plant, a giant herb, grows up once a year and then dies down, after which a new shoot comes up again. A bunch of bananas may weigh about seventy-five pounds. Bananas are shipped green and kept at a low temperature in the boat. They are ripened for sale by raising the temperature.

"The most delicious thing in the world is a banana," said Benjamin Disraeli, a noted English statesman. And so many people are near to agreeing with him that banana plantations spread like vast low forests through many tropical countries. The armies of Alexander picked this nourishing fruit in India more than three hundred years before Christ. Since then its cultivation has spread around the globe, and whole races make it their staple article of diet. Its gigantic leaves shed the rain from a roof, will serve the grocer as wrapping for a parcel, or do duty as an umbrella or raincoat. And the fibers of a kind that is not good for food form the Manila hemp that is woven into excellent rope or ground up to make Manila paper.

A FRUIT THAT MANY PEOPLE LIVE ON

In Many Tropical Countries People Rely on Bananas for Food Just as You and I Rely on Potatoes—and the Obliging Plant Serves Many Other Purposes Besides

JUST because our bananas come from the West Indies, many of us think they must always have grown there. But that is a mistake. The natives whom Columbus found in the West Indies were eating Indian corn and tomatoes, but they had never heard of a banana. The banana came from Asia at the start, though by the time of Columbus it had spread to many tropical parts of the Old World. Not until 1520 was it brought to the West Indies, but then it throve so well that in our day the banana groves of tropical America take up enough land to cover all the New England states. And it is from the tropics that we get all our bananas.

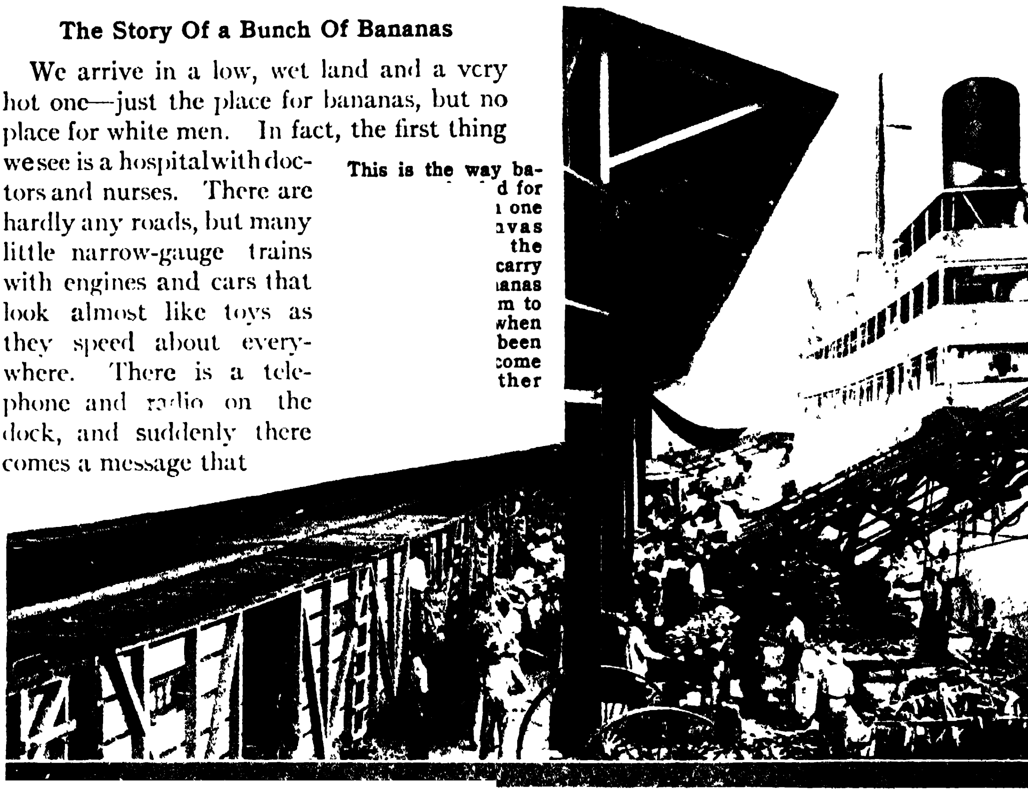
We have not always had them. In the old days of sailing vessels a banana was a rare thing in New York or Boston. The story of how we managed to get bananas is really the story of a race between two things —sugar and steam. Bananas are very rich in sugar, and therefore they ripen and rot very rapidly—so rapidly that they hardly ever stood the trip to New York in a sailing ship. Only after the steamboat came were they really well known in the north. But then a great industry began to spring up and grow until it now yields many hundreds of thousands of tons of bananas every year. To-day the industry employs many miles of its own railways and whole fleets of special ships, together with the radio and various kinds of ingenious machines—all to keep

the sugary banana from ripening too fast, or rotting before it reaches us.

It has taken us many a year to learn how to manage the banana and to keep it fit to send all over the country. Let us take a little trip to the banana groves to see how it is all done now.

The Story Of a Bunch Of Bananas

We arrive in a low, wet land and a very hot one—just the place for bananas, but no place for white men. In fact, the first thing we see is a hospital with doctors and nurses. There are hardly any roads, but many little narrow-gauge trains with engines and cars that look almost like toys as they speed about everywhere. There is a telephone and radio on the dock, and suddenly there comes a message that



This is the way ba- d for ı one ıvas the carry ıanas m to when been come ther

a ship is due in two days and wants forty thousand bunches of bananas, prime grade.

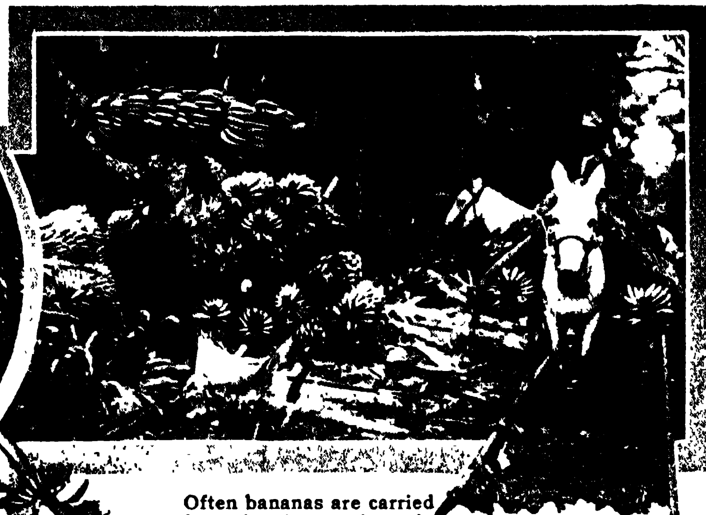
Hundreds of men, mostly Negroes, start at once on the toy trains for the banana fields, often many miles away. Night and day the trains are loaded with green, unripe fruit—never with ripe, yellow bunches—and start back for the dock.

Before the ship arrives it has started to force air artificially chilled into all parts of the hold. Day and night, by special machinery, the ship is loaded full, each bunch of the fruit being handled very carefully but very fast. Finally men go down among the racks of bananas to see that the thermometer never gets much above or below fifty-six degrees. This keeps the bananas from ripening.

Now the ship makes all speed to the north, and trains that have been called by radio meet it at its port. The bananas are lifted out of the ship and into the trains on great endless belts, each "link" carrying one bunch. Really the "links" are canvas sacks that carry the fruit from the ship to the waiting train. The cars are heated, or cooled, to fifty-six degrees, and the fruit is soon speeding over the country.

Finally the bananas are almost ready to eat; but not quite, for they must still be put into a "ripening room." Here the temperature is what it would be back on the hot plantation. In a few hours the fruit turns yellow and the sugary flavor, so long held in check, is properly developed. And then—but the rest we shall leave to your imagination! Only do not try to eat it until it is quite ripe—that is, until the skin shows brown spots.

A bunch of bananas grows on one of the largest herbs in the world, often twenty feet high. It is a stout herb, for it must hold up to the tropical sun a bunch of fruit that



Often bananas are carried from the plant to the train in "slings" across the backs of pack animals, as shown above.

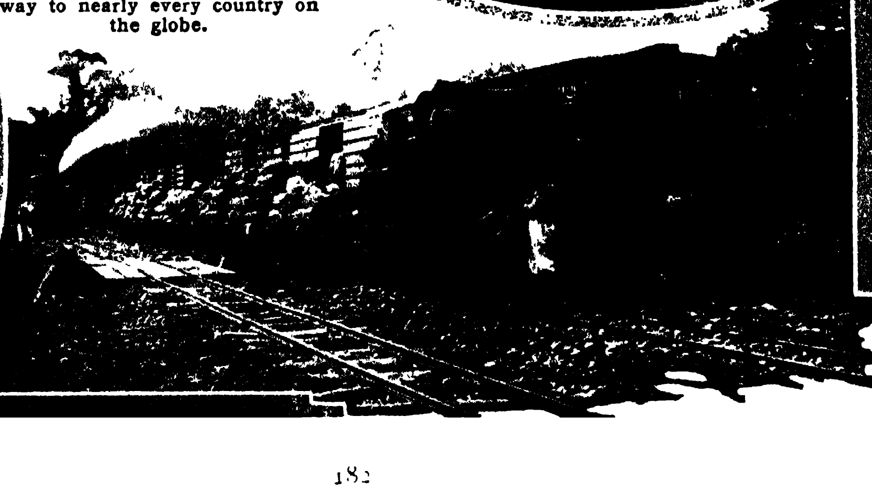
Grown bunches of bananas are gathered at least once a week on a given plantation, for planting, cultivation, and harvest all go on the year round. Above, a "cutter" is shown severing a bunch of green bananas from the stem with a heavy knife.

A bunch of bananas is received, as it is cut from the tree, on the back of a workman called a "backer." He often "backs" his load all the way to the train, as the native below is doing.

Above: A baby bunch of bananas that has just emerged from the bud.

Oval: Tucked away in this bud, which appears at the top of the plant's stem, is a tiny green bunch of bananas.

Below: At the loading depot, where the bananas have been brought on the backs of men or animals or by tram, the bunches of newly-harvested bananas are loaded on trains to be carried to the dock. There they are transferred to ships for a long journey to the world's great markets. Eventually they will find their way to nearly every country on the globe.



These rows of bananas have all been hung up in an especially constructed room to ripen.

At the right is a native harvest hand, or "backer." He is carrying the long pole and heavy knife that are used in harvesting bananas.

weighs from fifty to seventy-five pounds. And yet its immense leaves are as easily torn along the veins as the leaves of this book. In the tropics the wind tears the banana leaves to ribbons, but this does not hurt the plant at all. Indeed, some people think that nature arranged this tearing just in order that the tattered giants could ride out a storm and live to ripen their fruit.

When the fruit has ripened, the plant dies down to the ground. But the root lives on and sends up a new shoot often several new shoots. A new shoot looks a little like a sword, and the banana growers call it a "sword sucker." It is from these sword suckers that banana plantations grow up, since the fruit has either no seeds or such poor ones as would never sprout. Banana fields look very different from cornfields, for the banana plant grows so large that the young sword suckers are planted twenty feet apart each way. But they do not stay in straight rows very long, because new sword suckers keep starting up on every side, and as these spread out from the old root the field begins to look like a crazy-quilt pattern of scattered banana plants. Every farmer boy knows that such fields cannot be cultivated with machines, like cornfields. Thousands of men must do the weeding by hand.

Besides the common banana, as we all know it, there are some other kinds that most of us never see. One of these is far sweeter than the common yellow kind, but rots so fast that it is hard to carry even on the fastest ships. It is the little red banana, with a rusty red skin and sweet yellow flesh. The fruit is only a few inches long. Every tropical child knows and loves this little banana, but we hardly ever see it here.

The best-known banana in the world is also one that we never see in the north. It is a great green banana that never gets yellow and is so starchy it cannot be eaten raw. Every day hundreds of millions of people in tropical countries use this green banana, mostly called "plantain" or "platano." They cook it just as we cook potatoes. Nearly every house in the tropics has a plantain patch, so that more people eat plantains than ever eat potatoes.

Reading Unit
No. 17

A FRUIT THAT IS NOT A FRUIT

Note: For basic information not found on this page, consult the general Index, Vol. 15.

For statistical and current facts, consult the Richards Year Book Index.

Interesting Facts Explained

The value of the Hawaiian pineapple crop, 9–185
Why the pineapple is not a fruit, 9–185
Why pineapple juice is good for us, 9–186
How pineapples reproduce, 9–186
How Filipinos make cloth from pineapples, 9–186

Things to Think About

What happens to the flowers of a pineapple?
What part of the pineapple is most like a fruit?
How can a seedless pineapple reproduce?
How often must pineapples be planted?

Picture Hunt

What sort of clothing must pineapple gatherers wear? 9–185
How are weeds kept out of a pineapple field? 9–186
What part of a pineapple is planted? 9–186

Related Material

What is the work of plant enzymes? 2–53
How did the pineapple get its name? 2–119
What kind of fruit is the pineapple? 2–118-22
Where are the largest pineapple canneries in the world? 8–459
How can pineapples be ripened ahead of time? 2–219
How are pineapples canned? 9–230

Leisure-time Activities

PROJECT NO. 1: Make some pineapple lemonade, 14–188.
PROJECT NO. 2: Cut off the crown of a pineapple and plant it in wet sand. Keep it in a warm, sunny place, 9–186.

Summary Statement

The pineapple, which is one of Hawaii's most valuable products, is really not a fruit. The flowers do not ripen into fruit, and no seeds are produced. Each year's crop grows either from "suckers," or from the crowns, which are cut off at the canneries and replanted.

Photo by Hawaiian Pineapple Co

Most people know the pineapple only from having seen it in crates at the grocer's; very few would recognize it in the field, where it is half hidden among a mass of leaves. Gatherers must be careful to wear stout clothing to protect them from those leaves, which are shaped like swords—and almost as sharp!

A FRUIT THAT IS NOT *a* FRUIT

How a Prickly Jungle Plant Grew into Our Modern Pineapple, and Became More Valuable than All the Inca's Gold

IN THE jungles of South America the greedy Spaniards who crossed the seas in the wake of Columbus found a curious plant that was worth more than all the gold they stole from the Incas. Of course no one knew in 1540 that this spiny-leaved growth, with its curious flowers and rather poor fruit, could be developed into our modern pineapple; and it is only within the last fifty years that the canning industry has shown us that the pineapple crop in Hawaii alone may be worth many millions of dollars a year. The original plant gave no hint of its real value. So the Spaniards went ahead, murdering and stealing, and left it to men who came later to reap the riches to be made from the strange-looking fruit—which in spite of its name, has nothing to do with a pine tree nor yet with an apple.

Modern pineapple plantations are very prickly places. All the leaves, and many basal "suckers," have spiny margins, so that harvesting pineapples is a delicate business for bare-legged natives. The plant sends up from the center a stout stalk with a compact flower cluster of violet or reddish blossoms near the top; this stalk is crowned with a terminal rosette of spiny-margined leaves. There are also many spiny bracts, or tiny leaves, scattered through the flower cluster, which gives no hint that it will ever produce one of the juiciest and finest fruits of the Tropics.

In all modern varieties of pineapple the flowers are practically sterile (stĕr'ĭl); that is, they rarely or never produce a fruit. What we call the "fruit" is really a remarkable structure that is not a fruit at all, for unlike all true fruits, it is not a part of a ripened ovary. Pineapple fruits are merely a conglomeration of the main flower stalk, the prickly bracts, and the individual flower stalks, all fused into one juicy mass.

The only part of a pineapple that might be called a fruit is the outer shell of prickly segments. Even these are only the remnants

Photo by Hawaiian Pineapple C

Here you see a group of Hawaiian workmen cultivating rows of pineapple. Between each row is a long strip of "paper mulch," which is put there to keep the ground moist and prevent weeds from growing.

of unfertilized flowers; and we throw them away as we cut the rind off the fruit. But this outer rind of false fruits does help to preserve the delicious juice and the spicy fragrance of a pineapple. That juice, which is so popular as a "pineapple drink," also contains one of Nature's most valuable digestive products. This is a substance called an "enzyme," which aids in the digestion of proteins, especially meat.

But most people love pineapple only for its flavor, which is just as good when the fruit is canned as when it is in its fresh state. No other tropical fruit has such a fine fragrance. And this flavor and fragrance are all the more remarkable because the pineapple is not a true fruit, and never produces any seeds in its cultivated state.

While pineapples are grown in all tropical countries, Hawaii produces more than any other region. The plant needs great heat and plenty of rain. Both are found in Hawaii, where pineapple plantations cover hundreds of square miles. Thousands of natives work to take care of the fields, and thousands of laborers work in the canning factories, which are all near the plantations.

Where New Pineapples Come From

Perhaps you are wondering why the pineapple does not die out, since it produces no seeds. Most seedless plants would disappear if man or Nature had not provided some other method of propagation. But the pineapple is in no danger. Pineapple plants are produced by the million every year, wholly by the rooting of the basal suckers or of the "crown" at the end of the fruit. When we buy a fresh pineapple this crown of leaves is always on it. But the canning factories cut it off and plant it in sand—just as you may do at home, if you care to. If you keep this cutting in a place as warm and moist as the Hawaiian pineapple fields, it will root and grow into a new pineapple plant. The basal suckers, which are never seen away from a plantation, will also take root and grow.

How the Pineapple Reached Europe

A steady supply of new plants is produced in this way; and they are badly needed. For since the pineapple plant flowers and fruits only once, millions of new plants must be set in the fields every year.

When the first pineapple reached England, in the reign of Charles II, it was a rare and costly fruit. The Spaniards called it "piña" (pē'nyä), and it is still so called in all Spanish countries. Before it journeyed to Europe as a delicacy the Spaniards took the plant to the Philippine Islands, where it is widely grown to-day. Though the Filipinos like its fruit, they nevertheless grow the plants so close together that the crop hardly produces any fruit at all. This is done because crowding the plants makes them grow much longer leaves, and it is these leaves that the Filipinos want. The natives scratch out a fine white fiber which is spun into a thread and then woven into a smooth, durable fabric.

Reading Unit No. 18

THE LORDLY PALM

Note: For basic information not found on this page, consult the general Index, Vol. 15.

For statistical and current facts, consult the Richards Year Book Index.

Interesting Facts Explained

Why palms are grown in many places, 9–189
How palm oil is used, 9–190
The date palm, a tree with four hundred uses, 9–190-91
Why the pollen of the date tree is valuable, 9–190-91
The ten most important palms and their uses, 9–191

Things to Think About

What are the uses of palm oil?
What connection is there between railways and palm oil?
Where do dates come from?
How are female palm trees pollinated?
What products does man obtain from palms?
Under what conditions does the date palm grow?
What do you consider the most valuable tree to man?

Picture Hunt

Can coconuts float? 9–189
How are coconuts shipped in the Tropics? 9–189-90
Why is the date palm important to natives? 9–188
Can dates grow in the United States? 9–188

Related Material

Why are coconuts able to float? 2–149, 209
How long can a coconut live without sending out young shoots? 2–219
What is copra? 5–526
What does Palm Sunday celebrate? 7–609
Why is vegetable ivory important? 2–255
What is rattan? 2–253

Leisure-time Activities

PROJECT NO. 1: Make a dish of stuffed dates, 14–83.
PROJECT NO. 2: Visit a botanical garden to see how a palm tree looks.
PROJECT NO. 3: If you have never done so, crack open a coconut and drink the "milk."

Summary Statement

The palm tree is raised not only for its beauty but for the hundreds of products we get from it. Coconuts come from palms and serve many uses. Dates also come from palm trees in the Tropics, though California raises them too. In the Tropics, the palm tree keeps whole communities alive.

Photo by All Year Club of Southern California

What more could a philosopher or a lover of nature ask than to be allowed to live his life in the beauty and peace of this California date grove? The majestic palms would give him shade; and if that were not enough, the wood to build a house. He could make crude but serviceable clothes from the leaves. And as for *food*—all he would have to do would be to reach up and pick those ripe fruits.

by Bu of Agriculture, P. I.

Life moves slowly in the Tropics. These rafts of coconuts will float gently down the stream, relying on the currents to carry them to their destination. But eventually they will reach you in any number of delicious forms, as for instance in the flaky white ribbons which smother frosted cakes.

The LORDLY PALM

As Useful as It Is Beautiful, the Palm Has Long Been the Tree of Kings, and One of the Most Valuable Plants in the World

MANY years ago, when Brazil still had kings, one of the monarchs set a guard of soldiers to keep his subjects from stealing the seeds of his royal palms, which he had planted in a beautiful avenue in Rio de Janeiro. One may still see them growing there to-day. Now why was it that the monarch was so jealous of his treasures? The seeds were not good to eat. They had no milk, like the coconut. They were useless for making buttons, such as are made from the ivory nut. There was no oil in them, and consequently no fortunes to be made from them, in the way that millions have been made from raising the African oil palm. And since there is no fiber in their leaves, it was impossible to use the leaves for manufacturing rope or hats.

Why, then, did people want to steal the seeds, and why did the King want to prevent them? It was because of the beauty of the trees—the very reason why we like to have growing palms in our homes to-day. That Brazilian king had seen royal palms in the West Indies and had decided that they were so beautiful that he, and he alone, should have them. Such selfish kings can never hope to have their own way for very long. To-day royal palms grow everywhere in Brazil. And in every other tropical country hundreds of different kinds of palms are grown for no other reason than to please the eye of man.

Most of us will never see a full-grown palm. All our ideas of the tree must be gathered from pictures and from the florists' speci-

mens, which never mature and never could do so, unless we were to have greenhouses a hundred and fifty feet high. But in the Tropics palms are the single most striking feature in the landscape. Long before one's steamer enters a tropical port, one may see their slender stems, incredibly tall and stately, each bearing its crown of graceful leaves.

From that palm-strewn shore inland as far as the rain forest or the mountains, grow other palms of every kind, but they all have a single trunk, a crown of terminal leaves, and a fairly large cluster of small flowers. Their fruits may vary in size all the way from that of a cherry up to the double coconut which weighs sixty pounds.

One of Man's Earliest Friends

Long before man began to see the beauty of palms, he had found them of the greatest value to him in other ways. His chief interest then, as now, was in getting his food, lodging, and clothing; and palms have provided these necessities to all tropical people from the days of the cave man down to our own time. Modern machinery has enormously extended these simple uses, so that in the modern world palms have a place that could be filled by no other group of tropical plants.

Years ago missionaries found the natives of West Africa drinking "chops." That was the native name for a greasy oil which was boiled out of the fleshy husk of a palm fruit. It seemed pretty loathsome food to the Europeans, but some of them began experimenting with chop oil. They found that the tree from which it came was a tall, feather-leaved palm, bearing from two to three hundred fruits a year. Some of the oil was taken to England; and then it was discovered that in cool climates it was not an oil at all, but a kind of paste or fat. Chemists soon began working on it, with the result that African "palm oil," as it came to be called, has since grown so important that hundreds of thousands of tons of it are produced every year.

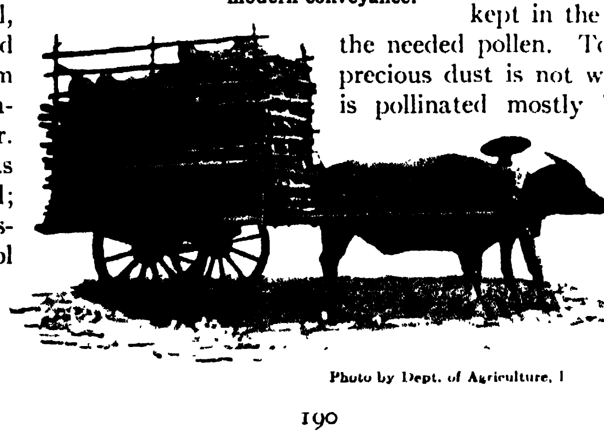
Most of it still comes from Africa, where scientific methods of treating the oily husk rescue more chop than the natives used to get. This fat or oil is used to make soap and candles, is burned for fuel, and is sometimes used by steel manufacturers to smear certain of their products before the coat of tin is put on. But its greatest use is for the greasing of railway axles. No other fat has ever been found to stand the terrific strain in that particular spot so well as this palm oil from far-off Africa.

Many other palms yield valuable oils; whole countries have been made rich from copra, babassú, cohune, urucúry. They are now used, not only as food for savage tribes, but in every kind of industry. They lubricate machinery, from watches to railway trains, and go to the making of artificial butter, candles, vast quantities of soap, and even perfumes.

Where Our Dates Come From

The palm everyone should know best is the one that yields dates. It is so valuable that in some countries every tree is counted and taxed. That seems a bit unfair, perhaps, for many date palms never can bear any fruit. This is because the tree is one on which male and female flowers never occur on the same plant—and of course only the female flowers ever turn into fruit. But enough male trees must be kept in the plantation to supply the needed pollen. To make sure that the precious dust is not wasted, the date palm is pollinated mostly by hand; and some growers are so anxious to plant only trees that will bear fruit that they have no male trees at all.

The pollen of the date palm lasts so long that in some parts of Arabia



Compare this cart with the trucks that bring your grocer supplies from the wholesalers! Coconuts begin their journey in a simple oxcart like this one from the Philippines. But before they reach our tables they see many a modern conveyance.

Photo by Dept. of Agriculture, I

there is a regular business in the sale of bottled date pollen. A grower may get his pollen from trees a hundred miles from his plantation. It is put up in little cloth bags which are carried to every female flower cluster in order that the pollen may be thoroughly dusted over the flowers.

That method of pollination is seen to be pretty costly when one realizes that many millions of trees have to be so treated every year. But the growers think it is worth while, for the date palm has been the friend of all tropical desert tribes for over six thousand years. Besides its fruit, it gives its leaves to be made into hats and mats, its trunk to be made into lumber; in fact, some Arabians say that the tree has over four hundred different uses.

We in the north value the date palm for just one thing for its rich fruit, which contains more easily digested sugar than any other fruit known. No wonder shiploads of dates are rushed to America and Europe after the yearly harvest.

The date palm has very long feathery leaves, a crown of which arises at the end of a short trunk. All the lowest leaflets are likely to be spiny, so that pollinating and picking dates is difficult work, especially in the heat. And no other palm in the world grows in the temperatures that the date palm can stand. In most date-growing regions the thermometer registers 100° F. on every summer's day, and in some of them it ranges between 110° and 120°. And more than that, the climate is usually so dry that the palms must be well irrigated, though the water is always cut off while the fruit is ripening. The full sweetness and flavor of a date can be developed only when the plant is thirsty.

Palms are so useful both to civilized and primitive man that the palm family is often said to yield the most valuable products of the Tropics. That may not be quite true; sugar, coffee, and chocolate sell for millions of dollars every year. But it is true that to most tropical peoples palms are the truest of all plant friends. Food, clothes, oils, ropes, hats, houses, medicines—all these and a hundred other valuable products the natives of the Tropics get mostly from palms.

Books have been written about the beauty and uses of palms. We could fill this volume with stories of over 1,500 different kinds of them. But we shall not do that. Instead we shall give you the names and uses of ten of the most important palms in the world:

Name of Palm	*Home*	*Chief Use*
Coconut	Old and New World Tropics	Oil and food
African oil palm	Africa	Oil
Date	Arabia and vicinity	Food
Sago	East Indies	Food
Carnauba	South America	Phonograph records
Betel	Malayan region	Stimulant
Sugar Palm	Indo-Malaya	Starch and sugar
Rattan	Indo-Malaya	Canes and wicker furniture
Palmyra	India	Sugar, vinegar and timber
Piassava	Brazil	Fiber for brushes, brooms, etc

Reading Unit No. 19

THE FINEST FRUITS IN THE WORLD

Note: For basic information not found on this page, consult the general Index, Vol. 15.

For statistical and current facts, consult the Richards Year Book Index.

Interesting Facts Explained

Why some fine tropical fruits are never seen by us, 9–193

The avocado or alligator pear, 9–194

The juicy mango, finest of tropical fruits, 9–194-95

The papaya of the Tropics, 9-195-96

How natives make meat tender, 9-196

Quince and guava jelly, 9–196

Other tropical fruits, 9–196

Things to Think About

Why are tropical fruits rarely seen in the north?

How are avocados eaten?

How does the United States Department of Agriculture make fine tropical fruits available for us?

What important medicine is obtained from papayas?

What are some of the most important of tropical fruits?

Do you think you would tire of tropical fruits sooner than of our native varieties?

Picture Hunt

Why are tropical fruits hardly known to us? 9–193

What tropical fruit makes a fine salad? 9–195

Where do cherimoyas come from? 9–195

How much may a papaya weigh? 9–196

Related Material

How do northern fruit growers protect their fruit orchards from frost? 1–237

What are Mexican tortillas made of? 7–43, 81

What does stomach pepsin do to proteins? 2–356

What has been the history of orange growing? 9-170-73

Where did the navel, or seedless, orange originate? 9–175

Leisure-time Activities

PROJECT NO. 1: Visit a large fruit market. You may find some tropical fruits rarely seen here, 9–193.

PROJECT NO. 2: Buy an alligator pear and make a salad out of it, 9–194.

PROJECT NO. 3: Try some guava jelly on toast, 9-196.

Summary Statement

If tropical fruits did not spoil readily, our markets would provide us with some of nature's finest fruits. The most famous of tropical fruits are the assai, mango, avocado, papaya, guava, and breadfruit. We can eat ripe avocados in salads.

Photo by Gran

How many of these strange fruits can you recognize? You have probably never heard of most of them. Yet the people of the Singapore Straits Settlements, where this photograph was taken, could tell you the name of every one of these fruits, just what sort of tree it grows on, and just what its flavor is.

The FINEST FRUITS *in the* WORLD

Have You Ever Eaten a Mango, or Tasted an Assai? And What Would You Say to Digesting Your Beefsteak with a Slice of Papaya?

NEARLY anyone who goes into a great city market for the first time will see there fruits of whose existence he never even dreamed. They come from all over the world, and have been brought to us with infinite pains, that their fine flavor and texture may be as nearly as possible like the flavor of the freshly gathered, ripe fruit. But in spite of all this effort, there are many tropical fruits that we have never heard of. Except for oranges, bananas, and pineapples, all of which we have told you of on other pages of this book, few fresh tropical fruits come to our tables. Of course figs and dates reach America by the shipload, but nearly always as dried or cured fruit. Now all this is a pity, for the fruit markets of any tropical city are full of curious delicacies that few people can resist. They are among the finest fruits in the world, but most of them spoil so easily that they cannot be shipped, and so we never see them.

Some of them have strange outlandish names, like mombin, biriba, bilimbi, grumichama, or rambutan. If in Brazil you sometimes see a house flying a red flag, there is no need for alarm. It does not mean that the house holds a case of yellow fever or is

harboring revolutionaries. The flag is merely a signal that its occupants will sell you the beautiful red fruits of the "assai." No boy or girl would refuse ice cream flavored with assai. Its deep red fruit has a taste between pineapple and banana.

One visit to the Tropics, or even years there, could never teach us the names of all the fruits we see in tropical markets. A few of the more important are in the list at the end of this story. But a few of the others are so well known that you will want to find out more about them.

A thousand years before Columbus came, the avocado (ăv′ō-kä′dō) was a well-known fruit throughout tropical America. The Indians called it "ahuacatl," and from that the Spaniards made "aguacate," which is still the universal name for it in tropical America. Only in England and the United States is it called the "avocado," and some people still prefer to call it the "alligator pear."

That is not a bad name for the avocado, because it looks a little like an overgrown green pear, perhaps three or four times as big as an ordinary pear. But it weighs many times what a pear weighs, for it contains a large stone that takes up at least one-third of the fruit.

Avocado is a rare delicacy in New York, but the Mexicans have always said, "Four or five tortillas, an avocado, and a cup of coffee—this is a good meal." Growing avocado trees is almost as common to them as growing bananas. But the fruit does not keep well, so it is still a delicacy in northern markets. It is, however, grown widely in Florida and California.

Photo by U. S. Department of Agriculture

Jaboticaba is described as a grape-like fruit, but it is easy to tell from the picture above that it does not grow as any grapes do! Instead of swinging in bunches from a vine, the fruits cluster on the tree trunks like barnacles.

Here in the north we use the avocado only as a salad. We have never tasted the delicious dessert made of ice cream and avocado in Rio de Janeiro—nor the most famous of all avocado dishes, the guacamole of Cuba and Mexico. It is mashed with a dash of young onions and lemon juice to make one of the most delicious desserts of the Tropics.

The avocado is full of a very nutritious oil, and has a flavor unlike any fruit of the Temperate Zone. No way of cooking it has ever been discovered, but as a rich food-fruit, it is one of the most valuable of tropical products.

About twenty years before the Pilgrims landed in Massachusetts the Emperor Akbar planted an orchard of a hundred thousand mango trees in India. Some of those trees are still living. The people of India have cultivated the mango for more than four thousand years, and in the last four hundred years it has gone all over the tropical world. No other tropical fruit has been so closely woven into the religion and the lives of the people.

Mangoes are vastly more important than the apple, and are eaten in greater quantities. Hundreds of millions of tropical folk call it the King of Fruits. Perhaps this is true of the finest varieties, for they are remarkable for juice and flavor.

The original mango was a wild tree in India, with a somewhat stringy fruit about the size and shape of a lop-sided pear. It is very juicy, and has a large stone to which the flesh clings stubbornly. Centuries ago the gardeners of India began to develop the mango. They produced the marvelous fleshy varieties, which do not cling to the

stone. The common sort are so stringy that eating them outside a bath tub leaves one dripping with their rich sirupy juice. The improved varieties are not stringy and may be eaten as easily as a pear. The thin skin is yellowish red, or even quite red in some varieties.

Some fussy persons will only eat mangoes with a knife and fork. They never have the sensation of sinking their teeth into this finest of tropical fruits. The flavor can be compared to nothing else.'

So many people have prized the mango that there are over five hundred varieties of it in cultivation. Of these perhaps three dozen produce the finest mangoes in the world. All of them originated in the Orient, but the United States Department of Agriculture has introduced the best of them into Florida and southern California. The fruit cannot be grown anywhere else in this country, and it hardly ever comes to northern markets, for mangoes spoil very quickly. They are the best-known of all tropical fruit, but the least familiar in northern countries.

Photo by U S Department of Agricult

Many of us have seen avocadoes, or alligator pears, for sale in city markets; and we consider ourselves lucky if we may have a tiny slice of one in a salad. But the people who are used to seeing these fruits growing on the trees—as shown above—say that one does not really know what a delicious flavor the fruit has until one has eaten half a dozen of them!

When the Spaniards came to the West Indies they found a curious yellow fruit about as big as a small watermelon or a large squash. At first they took it to be a kind of melon. But its bright yellow flesh has a milky juice, and instead of growing on a vine, the papaya grows on a stout woody herb, which springs up with incredible speed to a height of from fifteen to twenty-five feet. At the top there is a crown of huge leaves, just below which hang the large fruits.

The papaya (pä-pä'yä) is even more perishable than the mango, so we never see it in the north. That is a great pity. Papaya has a delightful musky flavor, and is perhaps the most widely used breakfast fruit in the Tropics. It is served exactly like a muskmelon, and is now cultivated throughout the tropical world.

One of the native uses for the papaya taught northern chem-

These musky cherimoyas come from Guatemala. Each one of them weighs as much as two or three pounds.

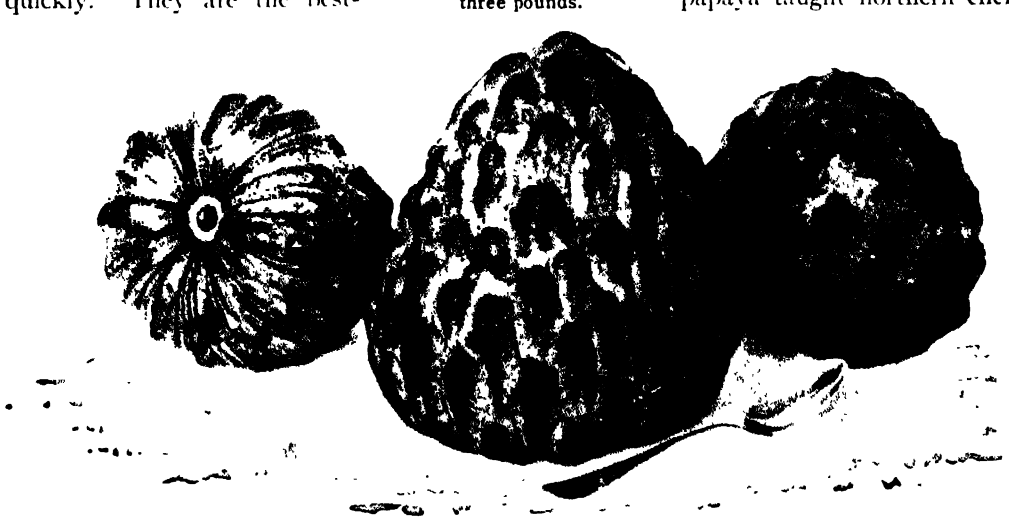


Photo by U S. Department of Agriculture

ists something that has proved valuable to all mankind. The natives found that tough meat rubbed with the juice of the fruit became tender. Sometimes it is enough merely to wrap the meat in the leaves of the tree and let it stand overnight. Chemists learned that the milky juice contains a substance almost exactly like pepsin. This is now manufactured from the fruit as an aid to digestion, so that papaya has become, not only a delicious fruit, but a highly beneficial one.

Most fruits are better raw than cooked. But two well-known ones are much better when cooked. One is the quince, which grows in temperate regions, and the other is the guava of tropical America. The Aztecs knew all about the guava, and their Spanish conquerors carried it over all the tropical world.

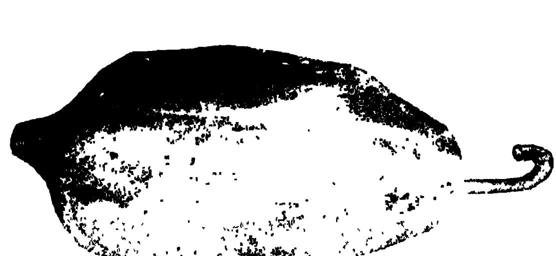
Though stewed guavas are delicious, we rarely see them in the United States—and this in spite of the fact that the canning of guavas is a large industry in Brazil. The fruit has one property which makes it dear to all housewives in the Tropics; it contains a sugar that makes it "jell" more easily than any fruit in the world. So it is not strange that guava jelly is now common everywhere. From it we may easily learn the guava flavor without ever seeing the fruit. If you do not know it, try a little guava jelly spread on a piece of toast or a cracker over which there is a film of cream cheese.

Guava trees are not large, like the mango. They bear white flowers about an inch across, which are followed by the roundish or pear-shaped fruit. This is usually yellow and has many seeds. We are beginning to grow guavas in California and Florida. They do well in both places, for they will stand more cold weather than the mango or papaya. There is already quite a large business in growing them for the guava jelly trade

No one book could tell about all the tropical fruits. Temperate climates have only a few staple fruit crops, but the Tropics have scores of them. If you ever go to Rio de Janeiro or Calcutta or to Africa, you must go without fail to the fruit markets. There you will be bewildered at first, as everyone is, by the variety of the wares. But buy a wicker or pam-leaf basket for a few cents, and carry home perhaps ten of the most important. You will have a rare treat. And if you have chosen well, your ten will almost certainly be:

Fruit	*Description*	*Originated in*
Cherimoya	Collective juicy fruit of a tree; very musky	Tropical America
Sugar apple	Like blancmange; fruit of a tall tree	Tropical America
Granadilla	Purple, fleshy fruit of a passion-flower vine	Brazil
Jaboticaba	Grapelike fruit of a small tree	Brazil
Sapodilla	Looks like a small potato; from the chewing-gum tree	Central America
Mangosteen	The tropical "Queen of Fruits"; from a tree	East Indies
Breadfruit	Looks like an Osage orange; tastes like a banana	Pacific Islands
Durian	Sweet, strong-flavored, custardlike pulp	East Indies
Tamarind	Sugary pods of a tall tree	India
Jujube	Sweet, crisp fruit largely grown in China	China and India

This papaya was grown in Florida, and weighs fifteen pounds! Unfortunately the delicious fruit is too delicate to be grown in the north.



It was probably quite by accident that the "digestive powers" of the delicious, musky papaya were first discovered.

Reading Unit
No. 20

A "NUT" THAT GROWS UNDERGROUND

Note: For basic information not found on this page, consult the general Index, Vol. 15.

For statistical and current facts, consult the Richards Year Book Index.

Interesting Facts Explained

The amazing number of products we get from peanuts, 9–198

The tremendous food value of peanuts, 9–198

Peanut growing in America and elsewhere, 9–199

Cousins of the peanut, 9–199

Why peanuts have to be dug from the earth, 9–199

Things to Think About

What useful things do we get from the peanut?

Where are large quantities of peanuts grown in the United States?

How do peanuts get into the earth?

Could you substitute peanuts for meat with pleasure and profit?

Picture Hunt

How are large quantities of peanuts removed from their shells? 9–198

What state grows many peanuts? 9–199

Related Material

What country produces more peanuts than any other? 5–473

Why should all campers take peanut butter along? 14–554

How does a plant make food? 2–40-46

What other seeds have to be roasted in order to bring out their flavor? 9–132

In addition to giving man and animals food, what other very important service do members of the pea family give? 2–168

Leisure-time Activities

PROJECT NO. 1: To make a "peanut man," see 14–13.

PROJECT NO. 2: Get some unroasted peanuts from a seed store and plant them according to printed directions. Watch the development of the fruit.

PROJECT NO. 3: To make salted peanuts, see 14–83.

PROJECT NO. 4: To make peanut brittle, see 14–86.

Summary Statement

Peanuts are favorites at the circus and baseball games, but most of the crop is used to make oils and fats, coffee substitutes, soap, linoleum, ink, and dyes. The shells make a good fuel, and feed for cattle. The nuts are rich in nourishment for man and beast. The flower stalk grows long and pushes the young fruit into the earth where the peanuts ripen.

Photo by Norfolk-Portsmouth Adv. Board

The picture above was taken on a peanut plantation when the workmen were threshing the peanuts and putting them into bags. In the circle you see the little ground nuts" themselves, growing on their stems and all ready to be picked and transformed into any one of the many products which have made peanut raising so profitable. Or perhaps they will be roasted and find their way to the trunk of some big elephant!

A "NUT" THAT GROWS UNDERGROUND

Have You Any Notion How Many Different Things Are Made of Toothsome Peanuts?

CAN you name a plant that helps to give us more than two hundred useful things, including the following: butters, oils, and lard compounds; an instant coffee substitute; sauces, pomades, facial creams, and shampoo lotions; linoleum, printer's ink, axle grease, and soap; seventeen different wood stains, dyes for cloth, and shoe blacking? The little plant is only a foot or two high, and probably is known to us only as the source of the toothsome brown "nuts" without which a circus would seem so incomplete. It is simply the peanut. But only a small part of the peanuts raised every year are roasted or eaten raw. Large quantities of them are made into peanut butter, which annually sells to the extent of several million dollars' worth. And still more are crushed or heated and made to give up their smooth yellow oil, which is excellent for salads and goes into a number of manufactured food products, as well as into all sorts of articles such as some of the ones we have named above.

Besides all this, peanut hulls, which we usually refer to as the "shells," may be fed to cattle like hay, the thin skins of the nuts may be used as a substitute for bran, and the leaves of the plant are almost as valuable as clover for fattening cattle. Three tons of the dry hulls are equal, when burned, to a ton of coal in fuel value, and the nuts are an excellent substitute for meat. For a pound of peanuts contains more protein (prō'tē-ĭn) —the substance that repairs waste—than a pound of sirloin steak, more sugar and starch than a pound of potatoes, and one-third as much fat as a pound of butter. No wonder

Photo by Norfolk-Portsmouth Adv. Board

This scene from Virginia, an important center of peanut growing, shows the peanut crop after it has been cut and piled into stacks that from a distance look a good deal like plump little fir trees.

we raise in the United States two billion pounds a year of this useful little nut, and import more than we raise. Thousands of square miles largely in Georgia, North Carolina, Alabama, and Virginia are planted to peanuts, and bring to their owners many millions of dollars a year.

But there are a good many other countries where the plant is raised. For though it probably came from South America in the first place, it is an accommodating little vegetable, and will make itself at home in any warm climate where it can have a light, sandy soil. India alone exports over a billion pounds of peanuts a year, and Senegal and China are also large producers. Much of the Far Eastern crop is bought by European countries; France, for instance, uses enormous quantities every year, a good deal of which she makes into oil for export. Altogether, the world uses several billions of pounds, or millions of tons, of peanuts every year. As you may see for yourself, the proportion of this that is eaten at the circus is not very large.

Now in spite of the fact that we have all along been referring to them as "nuts," peanuts are not nuts at all. They are cousins of peas and beans, and their "shells," or hulls, are really pods. There are two varieties of the plant, one of which is trailing, like a vine, while the other grows upright. Both kinds are cultivated like peas and beans.

But the peanut has developed a curious habit of taking care of its offspring, a habit that its well-known cousins have never hit upon. After the pistils of its bright yellow flowers have been covered with pollen, the petals fall off, the flower stalks grow longer and longer, and at last bend downward and push the little pods into the ground. There they are, safely buried in the earth and all ready to sprout when the proper time comes. It is these secretly-ripened pods that we dig up, to use their stored-up nourishment as food. You may see now why many people call them "ground nuts" or "earth nuts." We always have to dig them out of the ground, much as we do potatoes.

When we eat peanuts we have them delicately roasted to bring out the flavor that we like best; but the natives of tropical countries often eat them raw, and use the peanut oil to fill their lamps.

Reading Unit No. 21

FOODS DONE UP IN A SHELL

Note: For basic information not found on this page, consult the general Index, Vol. 15.

For statistical and current facts, consult the Richards Year Book Index.

Interesting Facts Explained

How nuts saved many people from starvation, 9–201
The size of our nut crops, 9–201
Different kinds of nuts, 9–201-4
How walnuts are grown, 9–202
Nuts from the hickory family, 9–202-3
The dangers of collecting Brazil nuts, 9–203

Things to Think About

Why will mankind be forced to eat more nuts in the future?
What family of trees provides most of the nuts for the world?
Why is the United States trying to grow more pecan trees?
Why are Brazil nuts hard to harvest?
How do Brazil nuts grow?
What nuts are really not nuts?
Which do you prefer to eat, nuts or meat?

Picture Hunt

Could you pick one Brazil nut from a tree? 9–201
How are walnuts picked in California? 9–202
Why are walnuts stamped? 9–203
What does the inside of a walnut packing plant look like? 9–204

Related Material

How are walnut and hickory trees used? 2–159
How are pine nuts harvested? 2–97
How do peanuts grow? 9–198-99
Why are American chestnuts rare to-day? 2–141

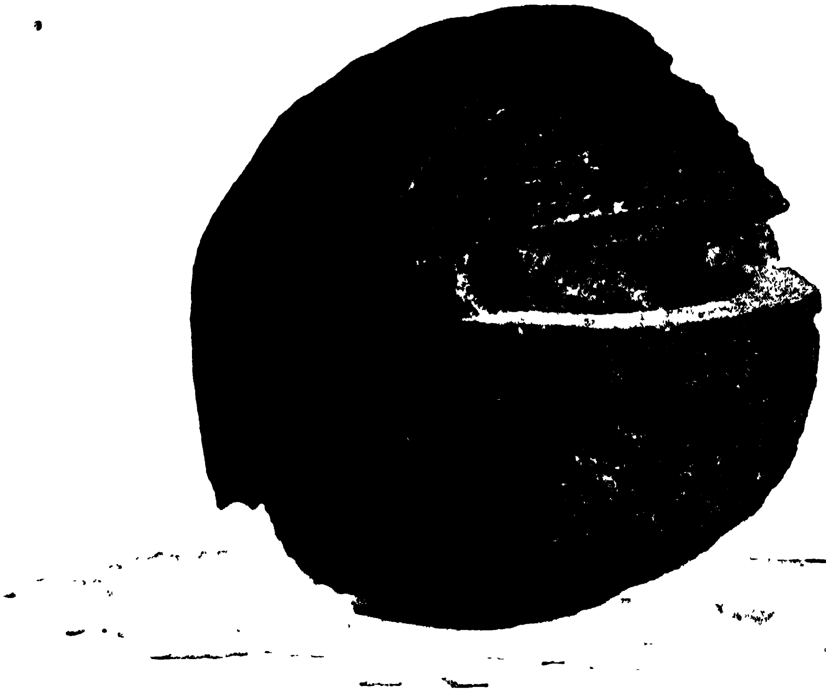
Leisure-time Activities

PROJECT NO. 1: Make salted almonds, peanuts, and pecans, 14–83.

PROJECT NO. 2: Make candy of different kinds from walnuts, 14–84-85-86.

Summary Statement

Nuts are being used more and more not only because they taste good, but because they are very nourishing. The walnut and hickory provide most of the world's nuts. The English walnut originated in Persia, but is now grown extensively in California. Pecans come from a kind of hickory tree. Brazil nut trees grow wild in the dangerous jungles of Brazil. Plant breeders are always trying to grow better nuts.



Here is the heavy wooden case in which sometimes as many as twenty-five Brazil nuts grow. A piece has been cut away to show you how all the little "niggertoes" are tucked away inside.

Photo by Visual Education Service

FOODS DONE UP *in a* SHELL

Nature's Most Valuable Storehouses of Food, and How We Get Them To-day

NUTS contain more real food than any other plant products. From the earliest times savages have known this, and the gathering of various wild nuts has always been more or less of a necessity with them. Some of our own Indians of the Southwest and Mexico would have starved if they could not have found their piñons (pē-nyōn′), which are the sweet, rich seeds of various pine trees. Later, as wheat and corn and rice became world-wide foods, nuts came to play a smaller part in the diet of civilized man, until to-day they are sometimes regarded as a delicacy. But many people think that as populations become more dense and the struggle for food grows keener, everyone will be forced to eat more nuts.

Nut culture is by no means an infant industry, even at the present time. Four commercially-grown nuts yield 375,000,000 pounds of food in the United States every year. Those four varieties, which are the most popular of all, are almonds, filberts, pecans, and English walnuts. The last are not English at all, but migrated to England and to California from their home in Persia.

Nature has scattered her nut-producing trees among many different families of plants. Some, like the coconut, are found among the palms; others, like the cashew and Brazil nut, grow on rare tropical trees. But in one small family of trees, found largely in temperate climates, she concentrated more nuts of commercial importance than are found in any other family—more, perhaps, than among all the other families put together. This is the hickory family. All of its trees are tall, and nearly all of them grow, or can be made to grow, in temperate climates. All have large compound leaves and small flowers growing mostly in catkins.

Courtesy California Walnut Growers Association. Photo by Art Streib Studio

As walnuts ripen, their green husks split open and let the nuts fall to the ground to be gathered by hand. **Usually, as is shown here, the trees are shaken with long hooked poles to help bring the nuts down.**

There are only about forty species of trees in the whole hickory family, and many of these produce inferior or little-known fruits. But the rest of the tribe give us what are perhaps the most valuable nuts in the world, for among them are the hickory nut, the English walnut, the American, or black, walnut, the butternut, and the pecan. All but the English walnut are natives of North America, and English walnuts are now grown on a huge scale in California.

The World's Great Walnut Orchards

Trees like the English walnut are very valuable. Of course they bear no nuts while young, so the nut farmer has to wait quite a time for his crop. But as they grow older they yield immensely valuable crops. Both in France and California it is not uncommon for a single tree to bear from 200 to 340 pounds of nuts a year.

The original wild Persian tree from which our English walnuts have descended did nothing like so well as this, and the nuts it grew were vastly inferior to the large, thin-shelled walnut we know to-day. Years of breeding and selection were needed to produce the modern walnut. Most of this was done in France and Italy, from which we still import millions of pounds of nuts every year. But California will soon become the walnut orchard of the world, for there are already many thousands of acres of English walnut trees planted there, and more are being added every year.

The Indians of the southern and central parts of the United States first told the Europeans about the pecan. It was an Indian nut, and from "pakan," the Indian name for it, comes our word "pecan." Of course the Indians never thought of growing the trees as a crop, or of trying to improve them. In fact, no one did much with the pecan until a very few years ago, when American plant breeders began to cross the various strains and to select the trees with the best nuts.

The Paper-shelled Pecan

What they were working for we now have. It is the so-called "paper-shelled pecan." Of course its shell is much thicker than paper. But the breeders have worked so well that you can now crush the shell between your finger and thumb. And the size and flavor of the nut have been enormously improved within the last thirty years.

Pecans prefer the warmer parts of the country, but at present the plant breeders are trying to persuade it to grow in the

colder parts of America. They have not quite finished the task, but a great deal has been accomplished. Groves of cultivated pecans are already creeping up the Mississippi and Ohio valleys. This is an excellent thing, for the nut is very valuable—more valuable than the English walnut. Millions of pounds of pecans are needed every year just for the making of various kinds of candy.

Why Not Plant These Nuts?

Other nuts in this remarkable hickory family are the hickory itself, our native black walnut, and the butternut. None of these are cultivated on so large a scale as the pecan and the English walnut, and our supply of them still comes mostly from wild trees. But anyone who has land too steep or too rocky for farming, will find that it will yield rich returns if only it is planted to the best varieties of black walnut or butternut. Both are delicious, but they are not yet developed commercially to such an extent as the English walnut and pecan.

Emptying into the great estuary which forms the mouth of the Amazon is another mighty river which has made its way through hundreds of miles of fever-ridden swamp to the south. Its name is the Tocantins (tō'kan-tēns'), and at its headwaters live some of the fiercest Indians in Brazil. But in spite of fever and savages, the river constantly carries a heavy traffic. It is from the lower four hundred miles of this unhealthy stream that the world gets nearly all its Brazil nuts. These nut trees are found in other parts of Brazil, always in the lower Amazon Valley, but the Tocantins produces more nuts than nearly all the rest of Brazil put together.

How Brazil Nuts Grow

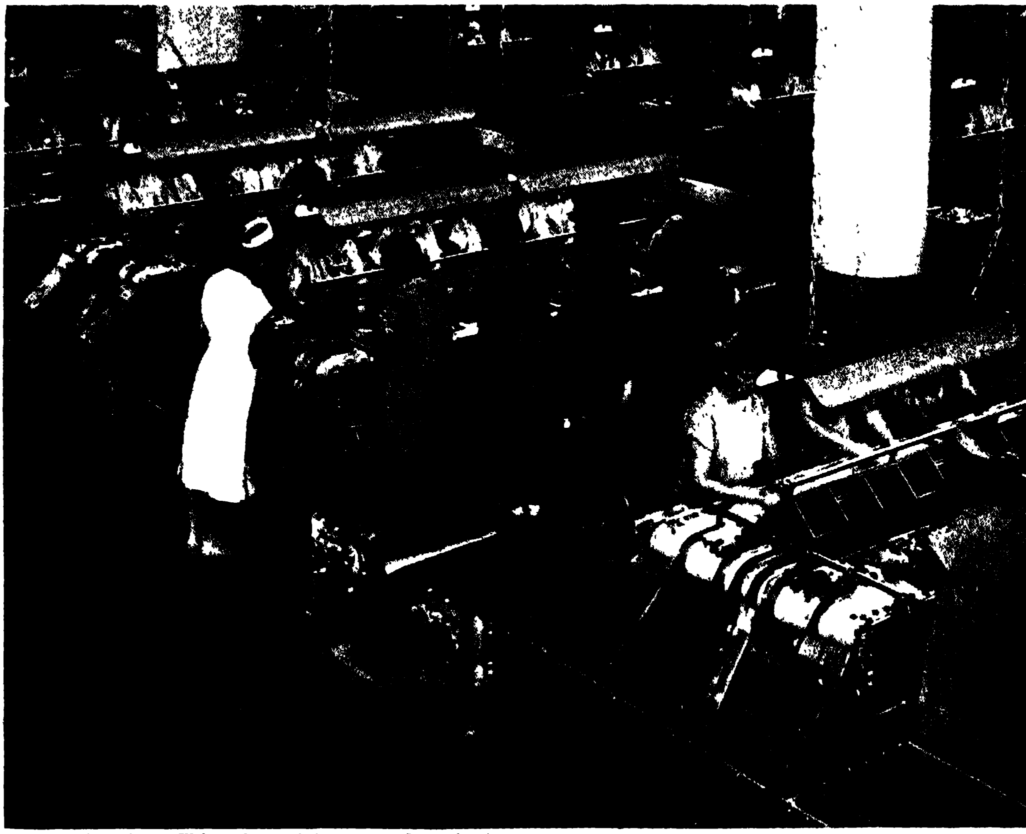
The Brazil nut tree is never cultivated; all the nuts have to be collected from the wild trees. Now these Brazil nuts—which some of you, perhaps, know as "niggertoes"—do not grow as as individual nuts on the tree. From eighteen to twenty-five of them are crowded into a hard, woody capsule—as is shown in our picture. It is nearly as large as a coconut and weighs about four and a half pounds.

The capsule does not split open to release the nuts. Like a round shot it falls unopened from the tree top. The great round balls are so hard and heavy, and there is such a bombardment of them at certain seasons, that native collectors run a good deal of risk when trying to gather them. For protection the workmen wear a tall pointed helmet, so that the falling capsules will strike them only a glancing blow. But in spite of this precaution, many Brazil nut gatherers are injured or even killed in this most dangerous of all nutting.

Perhaps the nuts are locked in this tight woody capsule to keep the monkeys from stealing them. Whatever its purpose may be, the little box is so strong that every capsule has to be split open with an axe or heavy knife. Then the nuts are shoveled into canoes, from which they are loaded on tugs bound for Pará, the city near the mouth of the river. In Pará there are docks groan-

Courtesy California Walnut Growers Association

This is the machine that stamps the trademark on walnuts.



Courtesy of California Walnut Growers' Associatic   Photo by Art Streib Studio

Our picture shows only a part of the great room in a modern nut-packing plant where walnuts are prepared for shipment. Everything is spotlessly clean, and the greatest precaution is taken to keep the nuts free of dirt and germs of all kinds. Of course nuts sold in the shell are sealed by Nature and need no protection against dirt or drying out. But shelled nuts do not have this advantage, so they are often packed in vacuum tins.

ing under the weight of the valuable nuts, which are waiting to be shoveled into bags, like loose coal, and loaded on steamers bound for America and Europe. The business is an immense one. It employs thousands of men and canoes, for nearly a hundred thousand pounds of nuts are shipped in good harvest years.

The tasty filbert is really a cultivated hazelnut, and like it bears round little nuts in protecting clusters of what look like tightly curled leaves. It grows well in Spain and is raised in the United States in large quantities. The almond, which flourishes in California and around the Mediterranean, is not a nut at all. It is the *pit* of a stone fruit related to the peach.

The rest of the more important nuts in the markets are in the following list. None of them compare in value with the pecan, walnut, or Brazil nut, the three most popular varieties.

Beechnut, from a tree native to Europe.
Cashew, from a tropical American tree.
Chestnut, from a tree, varieties of which grow both in Europe and in America.
Coconut, really the seed of the coconut palm, which grows everywhere in the Tropics.
Hazelnut, from a shrub, varieties of which are found both in Europe and America.
Pine nut, from a European stone pine; also from the various piñon pines of the Southwestern United States and Mexico.
Pistachio nut, from a European tree; mostly used to flavor confectionery and ice cream.

Reading Unit No. 22

THE MOST ROMANTIC OF OUR FOODS

Note: For basic information not found on this page, consult the general Index, Vol. 15.

For statistical and current facts, consult the Richards Year Book Index.

Interesting Facts Explained

Things to Think About

Why were spices once worth their weight in gold?
Why must vanilla pods be "cured"?
Why are vanilla plantations less profitable to-day?
In what ways are nutmeg and mace like each other?
From what are cloves made?
How is cinnamon made?
What modern table luxuries might be compared to spices for rarity ?

Picture Hunt

Related Material

Summary Statement

Spices have been used for centuries to flavor foods which otherwise might be unappetizing. In the Middle Ages so many dangers beset the caravans which carried these spices that only rich people could purchase spices. To-day, most spices are within the reach of all. They include such plant products as cloves, curry, ginger, caraway, vanilla, paprika, pepper, nutmeg, mace, and many others.

If the contents of the neat little cans and jars whose colored jackets make bright spots on the grocer's shelf could only talk, they might tell a tale as fascinating as that of Sindbad the Sailor. For spices come from strange lands. Above is a caravan carrying these romantic wares to market.

The MOST ROMANTIC *of* OUR FOODS

Battles Have Been Fought and Men Have Lost Their Lives That They Might Bring from the East the Odorous Spices to Give a Tang to Our Food

ONE of the earliest acts of the infant United States was to send a fleet of boats against the Barbary pirates, who for over a century had terrorized the Mediterranean. From their strongholds along the northern coast of Africa, they sallied forth to prey upon the richly laden ships sailing home from the Orient. And well it had repaid them, for hundreds of boats were engaged in what was known as the "spice trade," and their cargoes of spices and other goods from the mysterious East amounted to fabulous sums. Not even the gauntlet of pirate boats that vessels had to run could put a stop to the trade, which was largely in the hands of the English and the Dutch—though the Americans had a share in it and many an American sailor was sold into slavery by the savage gentry of Algiers and Tripoli.

It was not till 1830 that the hornets' nest was finally smoked out; and ever since then the fragrant spices of the East have come to Europe and America in ever-increasing amounts. Many people tell us that we do not need them, that we should be better off to take our food without any "fixings," since Nature intended us to take it so. But in spite of this advice people go on eating pepper and cloves and cinnamon and nutmeg, just as they did before. What would a plum pudding or mince pie be if we had no cinnamon or nutmeg? And how strange our cakes would taste without the familiar vanilla!

In the olden days the merchant in spices had a lively time. Barbary pirates were not his only foes. Savage natives and fever-ridden jungles made the trade dangerous enough to suit the most adventuresome. But to-day these hazards too have gone the way of the Barbary pirates. Spices are grown on plantations, and the great business of bring-

Photo by Keystone View Co.

This seems a strange way of peeling bark from the cinnamon tree; and it does seem a bit unsanitary, although feet are sometimes just as clean as hands! But the natives think it is a very efficient method, indeed—and of course all the spices are thoroughly cleansed before they ever reach you.

ing them overseas is safe and sure, though far less exciting than when young Stephen Decatur, in command of the "Enterprise," raided the harbor of Tripoli (1804) and burned a United States boat that the Barbary pirates had captured.

Only one of the well-known substances that we use to make food taste better is found in the New World; that is vanilla. Before Columbus arrived no European had ever heard of it. But the Indians of Southern Mexico knew how to use those long pods of a curious climbing orchid, and even grew them on a small scale. They used the delicate flavor to make their bitter chocolate taste a little better.

The plant needs hot, moist regions; so when it was taken from America to the East Indies, it throve there. Then after some years of experiment, it was found that the vanilla bean would grow better on some of the Pacific islands than on the mainland, and to-day a large part of the world's supply comes from the island of Tahiti. But the best is still grown in Mexico.

Getting Flavor Out of Pods

The flavor is all in the long slender pods. They are about as thick as your finger, and yellow or brown when ripe. But mere ripening, which takes several months, does not bring out their true flavor. They must be "cured," sometimes by dipping them in boiling water, which starts a fermentation in

Photo by N. Y. Botanical Society

People are so used to reaching up to the kitchen shelf for a can of powdered ginger or a bottle of vanilla that many of us do not know how these spices look in their natural state. Above are six little ginger roots; the long, dark pod is a vanilla bean.

These are not garlands that our Hungarian woman is displaying with such pride. They are strings of bright paprika. This spice is the dried fruit of a kind of pepper, and looks just as fiery as red pepper, though it really is much milder.

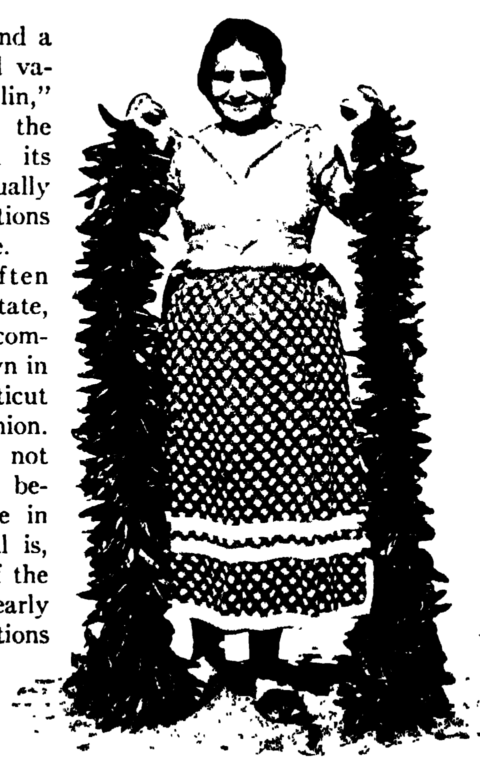


Photo by Hungarian Consul

them—though this is so delicate a process that it may sometimes ruin the pod. Growers have different ways of developing the delicious odor and flavor of the vanilla. Sometimes a grower will bury the pods in ashes until they shrivel, and then rub them in olive oil. Still others plunge them in rum.

Only about four hundred tons of vanilla are produced from vanilla pods, because the chemists have found a way to make artificial vanilla. It is called "vanillin," is almost as good as the natural product, and its manufacture is gradually making vanilla plantations less and less profitable.

Connecticut is often called the Nutmeg State, but the nutmeg of commerce was hardly known in America when Connecticut became part of the Union. Even in Europe it did not come into general use before 1790. The trade in nutmegs was, and still is, mostly in the hands of the Dutch, and to-day nearly all the nutmeg plantations are on the Dutch islands of the East Indies

The sweet-smelling nutmeg balls come from a small tree having yellowish flowers that are followed by a fleshy "drupe" about two inches long. Inside there is a single stone, the nutmeg we know so well. But as it comes from the fruit this stone is not quite ready to be grated into one of our puddings. For at its base there is a curious outgrowth which covers the nut with a crimson network. This covering, which is technically called an "aril" (ăr'il), has to be removed by hand. And this crimson network, or aril, is "mace," one of the most valuable spice products of the East—always expensive because of the delicate work of removing it from the nutmeg.

Few spices come from flowers, so it seems all the more strange that cloves should be merely the dried, unopened flower buds of an East Indian tree that is second cousin to the nutmeg. It grew wild only in the Moluccas, and from there the Chinese gathered it at least two centuries before the birth of Christ. It was so much prized that caravans carried it thousands of miles overland to Europe, where cloves were known as early as the

eighth century. But it did not grow common until the Dutch began importing it by sea about 1600.

Since then it has been widely grown in Penang and in Zanzibar, where the trees are usually set out about thirty feet apart. They do not flower for several years, but after the eighth year they produce some five to seven pounds of dried cloves each year. Every one of the blood-red buds must be picked by hand, so it is no wonder that cloves are pretty expensive. Their flavor comes from an aromatic oil they contain; and some plantations do nothing but grow them to press out "oil of cloves," which is widely used in making perfumery.

In far-off Ceylon there grows a second cousin of our common sassafras tree. You of course know the peculiar fragrance of sassafras bark: all the plants belonging to this family have a distinctive odor, just as the sassafras has. One of the strongest of these odors is camphor, which comes from another cousin that lives in Japan. But the Ceylon relative has a fragrance and flavor known all over the world; it is the well-known cinnamon

Ceylon is still the cinnamon garden of the world, although the plant is grown in India and in Java. Originally the cinnamon was a good-sized tree, but the growers hardly ever let it become so these days. For the flavor of cinnamon is in the bark of the young shoots, just as it is in sassafras. The plants are kept cut back so that they are mere shrubs. This constant cutting of the main stem forces the plant to send up a large crop of suckers from the base, and it is from the bark of these suckers that most of our cinnamon comes to-day. Skillful natives strip off the bark and peel off its outer skin. Then it is stretched over drying sticks, and left until it is quite dry. This is the reason why we usually get cinnamon in dried, brittle quills—though of course it may be ground to a powder. Unless it has been powdered, cinnamon is procured entirely by hand labor, so no one should be surprised that those woody sticks are expensive.

There are so many good things to flavor food with that we cannot tell the story of all of them. Most of them come from the Far East, a very few from America, and a handful from temperate regions. Besides those already mentioned the chief spices are:

Spice	*Derived from*	*Native in*
Curry	A powder made from over twenty different plants	India
Ginger	Rootstock of *Zinziber officinale*, a small plant	East Indies
Allspice	Unripe fruits of a small tree	West Indies
Pepper	Fruit of *Piper nigrum*, a climbing shrub	Tropical Asia
Turmeric	Rootstock of a small plant	Tropical Asia
Cardamon	Fruit of a small plant	Eastern Asia
Thyme	Foliage of *Thymus vulgaris*, a mint	Southern Europe
Caraway	Fruit of *Carum carvi*, of the carrot family	Europe
Caper	Seeds of a low, prickly shrub	Europe and Asia

Do you know these spices? The pretty cloves must be familiar to you, for they are often seen stuck into roasts of ham for flavor and decoration. The nutmeg you may have thought of as a powder usually seen on the top of rice puddings.

Spices were once worth their weight in gold. Only one of Magellan's five boats ever got back to Spain, but when it did, the cargo of spices it carried was valuable enough to pay for the whole expedition!

The STORY *of* STRANGE FOOD PLANTS

Reading Unit No. 23

STRANGE PLANTS THAT GIVE US FOOD

Note: For basic information not found on this page, consult the general Index, Vol. 15.

For statistical and current facts, consult the Richards Year Book Index.

Interesting Facts Explained

How tapioca is made from poisonous roots, 9–211-12

Uses of tapioca, 9–212

How breadfruit is grown and eaten in the tropics, 9–212

The ancient history of olives, 9–213

The many uses of olives, 9–213-14

The strange sources of manna, 9–214

The valuable soy bean, 9–214

Things to Think About

How is tapioca made from the cassava root?

Why is the breadfruit tree valuable in some Pacific Islands?

Why are olives important in the Orient?

What happens to most of the olives grown?

What is manna?

Why is the soy bean increasing in favor all over the world?

Can you think of other strange food plants?

Picture Hunt

What is soy sauce made from? 9–211

Why is the breadfruit so named? 9–212

Related Material

Why is the "resurrection plant" called manna lichen? 2–207

What has been the history of the Olympic games? 14–471

What has been the history of South American Indians? 5–493-501

How did ancient people make bread? 9–238-41

Leisure-time Activities

PROJECT NO. 1: Taking great care, stir some lye into a little olive oil, and boil the mixture. The particles at the top are soap.

PROJECT NO. 2: Squeeze some ripe black olives to remove the olive oil.

PROJECT NO. 3: Learn to make tapioca pudding.

Summary Statement

Tapioca comes from the big roots of the cassava, a poisonous plant. Natives shred the root, press out the poisonous juice, and then dry the pulp over a fire and use it in many foods. Breadfruit is very popular with the natives of Hawaii and the Philippines. Olives have provided valuable oil for thousands of years.

Photo by U. S. Dept. of Agriculture

This Chinese courtyard is filled with vats containing fermented soy beans, wheat, and brine; for in this way the well-known soy sauce is made. You have surely eaten it if you are fond of Chinese dishes.

STRANGE PLANTS THAT GIVE US FOOD

Did You Know That Tapioca Once Was Poisonous, and That People Eat Manna Even To-day?

IMAGINE eating food made from a violently poisonous plant! That is what we do every time we eat a tapioca pudding. Yet by the time we put it into puddings tapioca is as mild and healthful a food as you will find anywhere.

Ages ago the Indians of the Amazon somehow discovered the secret of this queer food. It comes from the big juicy roots of the cassava (kă-sä'vȧ) plant, one of the spruce family. The Indians call it "manioc" or "mandioca," and tell a pretty story about how they first came to use it as food. Now "mani" is the word in this Indian language for "boy," and "oca" the word for "hole." The legend goes that once the son of a king was buried with great ceremony. Later, when, according to their custom, the people went to dig up the boy's remains, behold! in the hole was no body but a great starchy root. This root, in one form or another, has become the chief food of the poor people in Brazil and in many other tropical lands.

The legend does not tell how the Indians who found this root learned how to take the poison out of it. But this is how they do it—for you may still see their crude mills along the Amazon.

The Indian women scratch the root all to shreds with a roller, the face of which is set with fearsome prickles gathered from a certain palm tree. Then they put the pulpy mass into a press worked by a long lever held down with great stones. In some comparatively modern mills the press is worked

by a mule which walks round and round and screws down a crude wooden plunger.

But even when as much of the poisonous juice as possible has been pressed out, the pulp is still far from fit to eat. So the next thing the Indians do is to spread the pulp out on large frying pans, often six feet across, and build a brisk charcoal fire underneath. As the mass heats up, little girls stand over it and constantly rake the pulp to keep it from burning. It turns perfectly white and looks like wheat flour, but the finished product is always much coarser than wheat. In fact, when the heat has driven off the last of the poison, and the tapioca is perfectly dry and ready to pack and use, its granules are about the size of radish seed, as everyone knows.

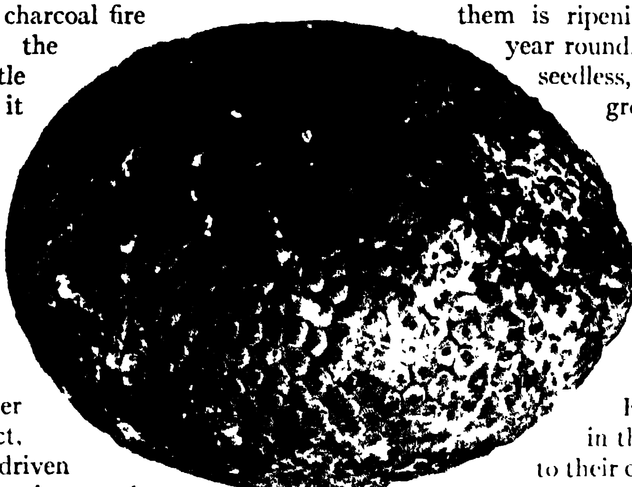


Photo by U S Dept of Agriculture

This is a breadfruit, a food tasting rather like a cross between soft bread and a cooked sweet potato! The natives of the Pacific islands eat it as regularly as we eat bread or potatoes.

The Brazilians use this starchy food, freed from its poisonous juice, in many ways—they make it into cakes and bread, they put great quantities of it into soup, and they like to eat it dry, sprinkled over fish or meat. The bitter cassava from which it is made has been introduced into many warm countries, and in some places it is grown widely for the trade in tapioca with other parts of the world.

And when we eat it in soup or in light fluffy pudding, little do we think of how much trouble it was to change it from a nearly-fatal poison to a fine and nourishing food!

What Is Breadfruit?

Breadfruit really does taste a little like bread, or perhaps more like potatoes—shall we say a cross between soft bread and a cooked sweet potato? Those who like it say it has a mild, pleasant flavor that one tires of no more than one does of potatoes and bread.

In many of the Pacific islands—in Tahiti, the Philippines, Hawaii, Samoa, Guam—breadfruit is a very important native food. It looks a little like a melon and grows on a tall, handsome tree. For thousands of years the Polynesians have cultivated it, and there are so many varieties that one or another of them is ripening almost all the year round. The best kind is seedless, and that is the one grown mostly to-day.

Europeans first heard of breadfruit about three hundred years ago. Supposing that it would grow well anywhere in the Tropics, the English decided, late in the 1700's, to take it to their colonies in the West Indies. The story of the first expedition of breadfruit hunters is quite romantic. For the captain and a few others were set adrift by the mutinous crew—who wanted to stay where they were—and sailed their tiny craft more than 3,600 miles to safety. But when the next year (1792) another expedition was more successful, the trouble seemed to be all in vain. For the West Indian Negroes did not care for breadfruit at all—and very few white people have ever been able to see why the natives of the Pacific islands like it.

They do like it, however, very much, and eat it as regularly as we eat bread or potatoes. They gather the yellow fruit just before it is dead ripe. Sometimes they cook it whole in the embers and scoop out the soft starchy center of it. Sometimes they cut it into slices and cook it between hot stones or bake it, if they have an oven. It can be preserved by being cut into thin slices and dried in the sun; from the dried slices the natives make flour for puddings and bread. As to the tree, they make cloth from the inner bark, glue from the gum, and very good canoes from the wood.

Photo by Soibelman Syndicate

This is a scene in an olive press in California. Here the ripe olives, which are stacked in long trays, will be made to give up their oil—for your soap and salad dressing, among other things.

Some people think that eating olives is an acquired taste, but if they are right, men had certainly acquired it a long time ago. The ancient Egyptians and Syrians knew the olive, the Hebrews thought it one of the main attractions of the Land of Promise, and the Greeks valued it above all other plants, as did the Romans after them. When the Greek athlete won a race at the Olympic games, he was crowned with an olive wreath; when the Roman conqueror rode proudly in his triumph, he wore an olive crown. For so dependent were these ancient peoples on the olive and its precious oil that it became for them the symbol of victory, of plenty, and of peace.

Long before modern chemists thought of making soap of olive oil, the women of Greece and Italy and the Orient—and some of the men too—used it constantly for their complexions and the health of the skin in general. But more than that, olive oil was, and still is, the chief cooking fat of the Orient. Wherever animal fats like butter or lard are hard to get, vegetable oils must be used instead; and of all vegetable oils the olive yields much the best.

The olive has been cultivated so long that there are a great many varieties of it, but they are doubtless all descendants of the wild olive tree of Syria, which is thought to have been the olive's original home. From that ancient home it brought with it a fondness for limestone soils, and for the warm regions near the sea. This is why it is so successfully cultivated along the Mediterranean, in Chile, in California and some of the southern states, in South Africa, and in Australia. The finest oils now come from Italy and Spain.

Left to itself the olive would be a very large tree, as well as one of the longest-lived trees in the world. But in commercial olive orchards the trees are usually kept low to make it easier to gather the fruit, and to crowd as many trees as possible on every acre of land. The tree has slender leaves, dark green above and dusted with white beneath, and little greenish flowers. The fruit, as everybody knows, is about the size of a large grape, oval, and bearing a single seed. When it is ripe, an olive is a dark purplish color, and very full of oil—the best varieties yield sixty to seventy per cent of oil.

Sometimes these ripe olives are eaten as delicacies, and one may buy them at almost any grocery, usually put up in tins. But oftener the olives meant to be eaten whole are picked while still green. They are then washed in alkali water, and bottled in brine

either with the pits left in, or pitted and stuffed with peppers. The so-called "queen" olives in the shops are not a special variety, but simply large and well selected fruits sold under this trade name. But scarcely a tenth of the olives grown, probably, are sold to be eaten like pickles for their delicate and piquant taste. The others are allowed to ripen and are then crushed for the sake of their oil.

The Truth about Manna

Usually when we say "manna" we think vaguely of some delicious food, like the ambrosia fabled to have been eaten by the gods on Olympus. That is because we have heard of how the ancient Hebrews lived on it in the wilderness, and of how it came to them as a miracle from Heaven.

As a matter of fact, no one is likely to eat manna if there is any other food about. But in many dry regions, especially around the eastern Mediterranean, there have always been people who at times were forced to eat it or perish. Not only the ancient Hebrews in the wilderness, but certain half-wandering tribes ate and still eat it and even buy it in the bazaars, often pressed into little cakes. As for the rest of the world, it either does not eat manna at all, or else uses it as a medicine to cure the stomach ache! This last use is widespread in South America.

Where Does Manna Grow?

The reason that manna has saved so many people from starvation is that it is a desert food, which is often found in desert lands when all other food fails. There are many varieties of it. One kind is a lichen, and you may know about it already, for we have spoken of it in the story of lichens. But the manna of the Bible, and the manna still collected or even grown for medicine, is not a lichen, but a gummy, sugary material that comes out of the bark of several desert shrubs and trees. It is sweeter, has a richer food value, and is much more widespread than the lichen manna.

The commonest source of manna is a desert shrub of the pea family found in Southeastern Asia and neighboring regions. Its sugary tears are very small; they are quite gummy at first, but harden in the air and are both sweet and nutritious. Another very common manna tree is the tamarisk, a semi-desert plant. It secretes a sugary liquid that hardens in the air; but this tree bleeds only when stung by an insect. Less common kinds of manna are furnished by desert species of oak and willow, and a product very like it is scraped off the joints of a Philippine bamboo. None of these last are of much importance as food, but like the true mannas they contain manna sugar. The true manna bearers give out their precious sugar only in time of heat or drought—just when other food plants curl up and die. No wonder, after all, that to desert wanderers manna is as a miracle from Heaven!

A Bean with Many Uses

It is only of late years that Americans have come to know the plant that experts consider the most useful in the world. It is the soybean. This amazing relative of our own peas and beans has been known in China for 5000 years, and is the main food of the Chinese people, who call it the "soya." But for more than a century after it was brought to this country no one paid any attention to it. Then we realized that the oil which makes up fifteen percent of its bulk could be put to many uses and that the plant itself makes excellent food for cattle.

To-day soybean oil is used for oiling machinery, is highly nourishing as a salad and cooking oil, is made into margarine, and goes into candles and soap, where it is obliging enough to lather in salt water. It is used in making oilcloth and linoleum and paints and varnishes, and can, by proper treatment, be made to serve in place of the valuable tung oil that also comes from China. Many thousands of acres of soybeans help feed our live stock. For it is a fine pasture plant, is excellent in silos, and when dried makes satisfactory hay. The meal that is left when the oil has been taken from the seeds is one of the finest live stock and poultry foods in the world.

But many other uses have now been found

for this remarkable bean. The chemist has seized it eagerly and made it into plastics of the kind that depend upon casein (kā'sē-ĭn), the substance that composes the cheesy part of milk. Disguised in those plastics soybeans greet us on every hand. They make the coating for fine papers and sizing for cloth, they enter into water paints, serve as finishes for leather, and appear about the house in various forms—in clocks, fountain pens, chairs, and a host of other useful things.

One of our automobile manufacturers has been making steering wheels, buttons, instrument boards, and even automobile bodies out of soybean plastic. And he has also had it spun into a fiber that makes a very good artificial wool, a fabric that is considerably warmer than rayon. Eventually this textile, though not so good as wool, should be cheaper than any other textile made in the United States. Moreover, two acres of land put to grazing will produce only eight to ten pounds of sheep's wool but will yield four hundred pounds of protein suitable for soy fiber. The bean also helps to make artificial rubber, explosives, insecticides, printer's ink, various waterproof materials, and adhesives that are especially valuable for making plywood. We may be sure that chemists have only scratched the surface in their hunt for uses for this amazing bean. In fact it may well become the world's most important industrial raw material, with more tons of it raised for the factory than for any other purpose.

But we cannot be sure of that. Soyas have a fine future on our dining tables. As the years roll by and the earth is more and more crowded with people, soybeans may well come to be the main article of food all over the world. If they were, the human race would be better off, for they are the most complete natural foodstuff that we have. They are more concentrated than any other and contain more vitamins, proteins, and minerals. One pound of flour made from soybeans contains as much protein as thirty-one eggs or six quarts of milk or two pounds of boneless meat. It has twice as much calcium (kăl'sĭ-ŭm) as a pound of milk, and consequently goes twice as far in building bones and sound teeth. It is rich in vitamins B 1 and B 2, is a good source of vitamins E, K, and niacin, and has most of the minerals the body needs, such as iron, manganese, copper, sodium, phosphorus, and potash. It is lacking in vitamin C, the anti-infection vitamin, but that is added if the beans are sprouted before they are eaten.

During the Second World War soybean flour went into the famous K rations, or "iron rations," carried by American soldiers when they were fighting in the field and could not always be reached by supplies from the field kitchens. Naturally those little packages--one for each meal--had to concentrate as much nourishment as possible in the 6x6x4 inches that each contained. Of course the experts who planned the meals did not forget to include the soybean, along with the meat, candy, soup, coffee, malted milk, cheese, chocolate, and crackers that the packages contained.

Of course the soldiers could not stop to sprout soybeans to get their vitamin C, but it is easy enough to do at home, and gives us one of the best and cheapest of foods. For to the food value of the beans are added the advantages of a green vegetable. When we say that bean sprouts are richer in vitamin C than tomatoes are you will see how useful they are in the diet. But most amazing of all, they can be grown in from three to five days in any climate at any time of year in any room and without either soil or sunlight. It sounds like a fairy tale, but this is the simple way in which it is done:

One cup of soybeans is soaked over night in a quart of lime water. This is made by dissolving one teaspoonful of chlorinated lime in a gallon of water. In the morning rinse the beans twice in plain water and put them in a quart jar or milk bottle with cheesecloth or a piece of window screen over the top. Turn the jar upside down and stand it on two small pieces of wood for constant drainage. Then put it in a dark place or under a cardboard box. At morning and noon fill the jar with plain water and invert it again, and at night rinse the beans with

chlorinated water—to keep them from molding. Unless the beans were too old the sprouts will appear in from three to five days. They should then be kept in the ice box.

Sprouted soybeans can be served in a number of ways. They may be boiled and served hot with a tomato or cheese sauce, they may be fried in fat for ten or fifteen minutes with a little onion added, they may be steamed for from seven to ten minutes and then made with gelatin into an aspic jelly, or they may be combined in a casserole dish with meat, with onions and celery, with noodles or macaroni, or with green pepper and cheese. Since they are low in starch they should be eaten with a little bread, rice, or potato, but this very lack makes them an ideal diabetic food. They are an excellent nerve builder, also. The Chinese make soybeans into a delicious curd. And the vegetable will also yield a nutritious milk that costs only a tenth of what cow's milk costs and is sometimes preferred to it. Roasted and salted the beans may be eaten like salted peanuts.

Soy flour should be combined with wheat flour for bread and cake, but it needs no such help when it goes into cookies, ice cream, soups, gravies, stews, sausage, cereal, or similar dishes. An excellent meat loaf is made by mixing one-fourth pound of soybean flour with three-fourths of a pound of ground meat. Of course you can add any seasoning you like. Wherever this flour is used it adds nourishment to the dish and reduces its price. For it supplies all the essential food elements except starch at, roughly, one-fifth the cost.

No wonder soybeans already rank near the top among our country's grain crops, though China surpasses us in quantity production. Every year our farmers are planting more of them. We have just the climate the soybean likes, since it will grow wherever corn and cotton do, and makes very few demands as to soil or cultivation. Its 2,500 varieties endure heat and cold and flood and drought and can withstand every kind of pest except rabbits, who have a passion for it. Like peas and beans the soybean fixes nitrogen in the soil instead of taking it out, and so improves the fertility of the land. It fits neatly into a planting cycle of corn, soybeans, wheat, and clover. Two tons of soybeans plowed under equal seven tons of manure as a fertilizer. No wonder experts call the soybean the world's most useful crop.

Reading Unit No. 24

PLANTS THAT GIVE US MEDICINE

Note: For basic information not found on this page, consult the general Index, Vol. 15

For statistical and current facts, consult the Richards Year Book Index.

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How is quinine extracted from cinchona bark?
How were two important medicines for the heart discovered?
How is science taking the place of superstition in medicine?
Do you know of any superstitious beliefs that exist to-day?

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Summary Statement

Men of science have carefully studied the action of medicinal plants. Gradually, silly remedies have been replaced by accurate methods of curing disease, reducing pain, and helping the heart.

In these cotton-topped test tubes are growing molds from soils gathered far and wide. Some will yield aureomycin (ô'rē-ō-mī'sĭn), an antibiotic (ăn'tĭ-bī-ŏt'ĭk) —or killer of germs. This amazing drug, fed to meat animals, will increase their growth by fifty percent. Such a discovery goes a long way toward solving the food problems of a hungry world.

Courtesy Lederle Laboratories—American Cyanamid Company

PLANTS THAT GIVE US MEDICINE

A Few of the Plants That Come to Man's Rescue When He Is Ill

NEXT time you have to take a dose of cod-liver oil or castor oil, remember that if you had lived a hundred years ago you would probably have had to take something much worse. Just swallow it down and be grateful that modern science has taught mankind a good deal more than our forefathers knew about the use of drugs. For it is only some two hundred years since the juice of a snake, the dried, powdered skin of a toad, and various other substances too revolting to mention were solemnly swallowed in the hope of curing rheumatism and many other ills. In those days, as in our own, it was much more comfortable to keep well than to be cured.

It all began with the witch doctors and medicine men, before the dawn of history; for savages have always turned to nature for remedies, and it was the business of their priest to find out what would help them most. Certain of those strange early medicines must have had real value, and may well have come down to us to-day. But others were outlandish or terrible, and the medicine men soon learned how to practice all sorts of hoaxes on their helpless victims. It was thousands of years before mankind began to escape from all this ignorance and superstition—if indeed we have entirely escaped even to-day. But gradually men of science began to observe and to keep records, the study of plants was spread more widely, and little by little the old silly remedies fell into disuse.

This was partly because other much more valuable ones had been found to take their place. For in the leaves and flowers and roots and bark of certain of her plants, Nature had hidden powerful medicines; it only needed skill and patience to learn how to use them. Because men knew this fact, the study of botany was for a long time nothing but the study of medicinal plants. Many books have been written about the old uses of "yarbs," and from them modern

science has sifted about ten per cent that is of actual value. Even to list our present medicinal plants would fill a volume the size of the one you are now reading, for medical botany has given the doctor some of his most powerful and useful medicines. The old loathsome potions are gone, and gradually, as people become more highly educated, the ancient remedies are disappearing from the shelves of the drug stores; but certain of our medicinal plants the doctors would find it very hard to get along without.

One of these is quinine (kwī′nīn). Any white man who goes to the Tropics may find that he has caught malaria, that disease of chills and fever which is spread by the bite of a certain kind of mosquito. It has brought death to countless numbers of people. But since 1638 it has been robbed of many of its terrors. In that year the Countess del Chinchon, wife of the Spanish viceroy in Peru, fell dangerously ill of the disease, and in spite of all that her doctors could do, lingered on at the point of death. Finally one of her priests got from the Peruvian Indians the bark of a tree, from which a bitter drink was made and given her. Almost at once she felt better, and soon she got well. So of course people wanted to know about the wonderful bark.

Photo by Keystone View Co.

This native of West China is inspecting the seed pod of a poppy plant. After the surface of the pod is scratched, a milky juice can be extracted; this is later made to yield opium.

Trees That Give Us Quinine

They found that it came from a tall tree and was most bitter and unpleasant to the taste, but as "Peruvian bark" its fame spread over all the world, for it saved the lives of thousands of people. Later it came to be called "Cinchona bark," after the Countess; and to-day it is used by hundreds of millions who live in the mosquito-infested Tropics. Without it few white men could stay there.

It is no longer Peru that supplies quinine to the world. Most of our present supply comes from Java. Besides, certain yet more effective drugs, like atabrine (ăt′ȧ-brĭn), and some half dozen others that are certain cures for malaria are replacing it.

In Java chincona trees are grown on plantations, much as rubber is grown. The fresh bark is pounded off the branches and trunks with a stick, and after drying for a short time is shipped to Europe or America, where quinine in the form of a white powder is extracted from it.

If quinine has changed life greatly for people in the Tropics, another plant given us by Bolivia and Peru has made life endurable for people in every clime. For when the doctor or dentist wants to perform a minor operation without giving you ether, he sometimes uses a product of the "coca" leaf. This is called cocaine. It comes from the leaves of a shrub some six or eight feet high. They look much like tea leaves, and are often chewed by the Indians to relieve the fatigue of long marches without food. The Indians have had the habit for hundreds and hundreds of years.

Like the tree from which we get quinine, the shrub that gives us cocaine is now raised largely in Java, where the Dutch took it from Peru. It is from there that most of our cocaine comes to-day.

Still more useful than cocaine in relieving mankind of pain is the powerful opium. It comes from the milky juice of the unripe pod of the opium poppy. The intelligent Chinese consider the magical juice a poison, for the taking of it steals away men's wills and robs them of mental and moral power. In the end they die—a miserable death. But though

Photo by Keystone View Co.

Many are the trials and adventures of the camphor seeker, for the little island of Formosa harbors many strange things besides the camphor laurel—savage head hunters, for example! Above, you see some of the simple island stills which operate to give us the drug. Camphor chips are taken from the tree and heated, so that the camphor may vaporize. The vapor is then made to pass through bamboo pipes into sunken vats so arranged that cool mountain streams will flow over them. In those vats the camphor crystallizes.

the Chinese fought hard to keep the plant out of their country, where it grows easily, there were too many millions of people in other countries who wanted to feel its pleasant though terrible effects. So the other nations forced China to carry on the trade, and millions of Chinese are to-day bound to the deadly habit. Slowly the eating of opium has spread over the world, in spite of the efforts of all the nations to prevent its use. The United Nations has set up a permanent board to study the opium traffic and make recommendations for controlling it.

The Curse of Opium

Now the reason why people lose their wits and wills when they use too much of this drug lies in the fact that the taking of it grows into a powerful habit. As often as they take it, they go off into a dreamy slumber. Because it has this effect, the doctors have learned how to use opium to relieve pain. From it they extract a drug called morphine (môr'fĭn), which takes its name from Morpheus, the god of dreams. This is given in various forms. The patient feels a gradual dulling of all his senses and finally drops off to sleep. In this way relief has been brought to untold numbers of sufferers. And yet less than one per cent of all the opium grown is used for this noble purpose. All the rest goes to undermine men's bodies and minds.

Where Poppy Seeds Come From

Nature is full of freakish contradictions, as if the old dame liked to have her little joke with us. The tiny black seeds that often are used to ornament the outside of rolls, and give them a pleasant flavor, grow inside the pods that contain this terrible, if kindly drug. And these seeds you may eat without the slightest fear. They are quite free from the juice that has relieved so much

suffering in the world—and caused so much more!

Not far from the southeast coast of China lies the large semitropical island of Formosa, since World War II a Chinese possession. Its people are backward and quarrelsome, and no one cares to go there to live on account of the damp, hot climate. But Japan was very glad to annex the island after a war with China a good many years ago, for on it grow several valuable things, among them a tall and fragrant tree from the wood and bark of which we get our camphor. There are certain other plants that give us something a good deal like this pungent white "gum," but true camphor comes from this tree alone; and since it is hardly to be found outside this island, the Chinese have something like a monopoly of the product.

We value this strange substance with the clean, pleasant odor because it will make a person with a fever break out into a perspiration, and in this way bring down his temperature. We also use it to make camphorated oils and ointments, which have a soothing, cooling action; and we put it into certain remedies for colds, especially into those that we inhale to clear the nasal passages. But lately we have found still other uses for it. It goes to the making of smokeless powder and is employed in various chemical industries. On a large scale it is used in the making of celluloid.

How Strychnine Was Found

For hundreds of years it has been the custom of certain savage tribes to tip their arrows with poison. What the arrow does not accomplish, the poison will! But when the doctors came along to investigate the action of these terrible juices, they found that what would kill a man if he took it in too large doses, would save his life if it were properly administered. It was from one of these deadly arrow poisons that the doctors learned the use of strychnine (strĭk′nĭn), one of the best heart stimulants that has ever been found. It comes from the juice of a group of tropical trees and shrubs called "Strychnos," and a century or so ago it was still unknown, though the deadly arrow poison had been in use for centuries. To-day it saves the lives of many persons who have weak hearts. But it is still a deadly poison unless administered in very small doses, and by a physician.

Some two hundred years ago a gentle lady in an English garden began to experiment with the foxglove, a common enough flower in England, and one that we raise here in our gardens because of its beautiful lavender or pink flowers. The fact that the juice of the plant was deadly poison did not alarm the adventurous English lady, and as a result of her work and of that of later scientists we have one of the most important drugs in modern medicine.

A Deadly Poison That Makes Us Well

This is digitalis (dĭj′ĭ-tăl′ĭs), which not only stimulates the action of the heart but forces the blood to circulate more rapidly through the whole system. It is of the greatest value in the treatment of certain kinds of ailments.

Now of course there are times when a patient's heart beats too fast instead of too slowly. Then the doctor must find something to quiet it before it wears itself out. And where does he find his remedy except in a plant that has long been known as a deadly poison—in the monkshood, whose blue or purple flowers have ornamented our gardens for centuries! It belongs to the family of plants known as "aconitum," and so the drug it yields is called "aconite" (ăk′ŏ-nīt).

While the half-dozen drugs we have named are perhaps the most important ones coming from plants, there are many others that doctors would miss sadly. One of them is the useful and detested castor oil, which comes from a kind of bean native in Africa or India. The family name of the plant is "Ricinus." Another is atropine (ăt′rŏ-pĭn), or belladonna, a drug used in the treatment of eyes and also to check pain and spasm. It is taken from a European plant called belladonna—which translated means "beautiful lady." For this plant, also called "deadly nightshade," was known to Italian

ladies of long ago, and was used by them to give their eyes added charm and luster. Other powerful drugs also come from the same plant.

Everyone knows the pleasant, icy tang of menthol. It comes from a member of that delightful, peppery family known as the mints. Formerly we imported our menthol from the Far East, but Oregon has now taken to growing large fields of the mint from which it is made and nets a very tidy sum from it.

The jungles of South America give us an old-fashioned medicine that our grandmothers used to ladle out freely to crying babies and that is still widely used in cough medicines and to induce vomiting in cases of indigestion. It is ipecac (ĭp′ĕ-kăk), and it is made from the dried roots of a plant that belongs to the madder family. It is only in regions with a rainfall between sixty and eighty inches a year and a deep rich moist soil that we can find this useful plant—in other words it will flourish wherever the rubber tree grows. Naturally we get a great deal of ipecac from Brazil, but Central America also sends it to us. The Indians had used it for centuries before a French doctor took it to Europe (1672). For many years he kept the name a secret, but it finally leaked out.. Europeans did not, however, learn where it came from till over a century later.

The little country of El Salvador gives us one of our most powerful antiseptics, used especially as a quick dressing for wounds. It is mistakenly called "balsam of Peru." To get it we first take patches of bark from the tree that bears the name. The wood underneath the scar is then scorched with torches. The liquid balsam used for medicine comes from the pitch that flows out of the tree under the heat.

Ergot (ûr′gŏt), an important drug used to prevent excessive bleeding, is made from the fungus ergot, a common pest in the grain fields during warm moist weather. The pungent sarsaparilla, excellent for flavoring medicines, soft drinks, and candies, and also used as a tonic, is a much used drug made from the dried bark of the roots of a prickly smilax (smī′lăks) that grows in Mexico and Honduras. And chaulmoogra (chôl-moo′grȧ) oil, the famous but not very reliable remedy for leprosy, comes from three plants that grow in Burma and Siam. The important one is the handsome chaulmoogra tree, the seeds of which yield the oil that is used in treating not only leprosy but other skin diseases and rheumatism as well.

An Amazing Blue Mold

If you ever have to work around a laboratory when it is necessary for you to keep your materials germ-free you will be annoyed by a bacterium (băk-tē′rĭ-ŭm)—or very low form of microscopic plantlife—that grows a mold a good deal like the bluish mold in bread or Roquefort cheese. You will call it a nuisance and wish it had never been created. But in that you will be vastly mistaken, for this humble little growth—"Penicillium notatum" (pĕn′ĭ-sĭl′ĭ-ŭm nō-tā′tŭm) is its name—gives us the most powerful germ-killing substance known to man. It is perhaps the most valuable drug the doctor has, and its use certainly is one of the great medical discoveries of all time.

Unlike the drugs we have been talking about this one is comparatively new. To be sure it was discovered as early as 1929, but for a long time was treated as a Cinderella until its value was finally recognized during World War II. The original discovery had been an accident. Sir Alexander Fleming, an English scientist who was carrying on experiments with other bacteria, noticed that the substance—or "culture"—in which he was growing them was germ-free in the neighborhood of some mold that had got started in his culture. It was found that this mold, by its own process of living, manufactured a substance poisonous to other bacteria. That substance, which must be extracted from the culture in which the mold is grown, is called "penicillin" (pĕn′ĭ-sĭl′ĭn), after the mold that produces it. It has rightly been termed the miracle drug.

What Will Penicillin Cure?

Penicillin's amazing usefulness lies in the fact that it is deadly to a large number of

germs that give rise to some of man's most dangerous diseases. The so-called "sulfa-drugs," or sulfonamides (sŭl-fŏn'à-mīd), that came into use some years before penicillin did, are powerful enemies of the deadly streptococcus (strĕp'tô-kŏk'ŭs) germs, a family of bacteria that are strung together like a string of beads. But many terrible diseases come from other germs, especially from a class of bacteria that the sulfa drugs seem to find it harder to kill. Those germs belong to the "staphylococcus" (stăf'ĭ-lô-kŏk'ŭs) family of bacteria, and are strung together like a bunch of grapes. They are pus-forming germs, and cause bone infections, boils, abscesses, carbuncles, gonorrhea, blood poisoning, all sorts of inflammations in various parts of the body, and certain other infectious diseases most of which yield to this useful drug. Penicillin attacks certain heart infections which were hitherto fatal, certain kinds of pneumonia, two forms of meningitis, syphilis, yaws, anthrax, and some forms of gas gangrene.

A Powerful Germ Killer

We still have much to learn about the use of penicillin, and we still have to find out just what it is able to do. As originally made it was costly, for five hundred quarts of the liquid used as a culture for the mold will produce only an ounce of penicillin, and the process is a long one. But that little ounce is of amazing strength. Cultures of certain kinds of germs have been killed in only three hours by a solution in which the drug was only one two-millionth of the whole amount of the solution. When the drug is prescribed it is given in milligrams, with roughly about fifty of them to an average dose. But an ounce contains some 28,350 milligrams. So the precious substance goes a long way. In fact it is a thousand times as powerful as the sulfa drugs—so in comparison with other antiseptics it is said to be like radium in comparison with other ores. And perhaps best of all, if it is pure it is not poisonous to man, even in large doses. In this way it differs from the sulfa drugs. But penicillin must always be administered by a doctor and in its common form cannot be taken by mouth, for the stomach juices destroy it.

Since penicillin was discovered scientists have been experimenting with other molds to see if they will yield medicines. Already they have found even more powerful germ killers, such as streptomycin (strĕp'tô-mī'-sĭn), useful against tuberculosis. It is amazing to think what an important role has been given the humble molds.

Photo by Henricks Hodge

Over long and dangerous mountain trails the bark that yields quinine must travel out of the forest on muleback.

Reading Unit No. 25

THE WEED WE FOUND THE INDIANS SMOKING

Note: For basic information not found on this page, consult the general Index, Vol. 15.

For statistical and current facts, consult the Richards Year Book Index.

Interesting Facts Explained

Why the use of tobacco is harmful to many people, 9–221
How Indians smoked a pipe, 9–221
How tobacco reached Europe, 9–222
Why there are many grades of tobacco, 9–222
Where tobacco is grown, 9–223
How tobacco is grown and cured, 9–223–24
The revenue from tobacco, 9–224

Things to Think About

What deadly poison is found in tobacco?
How did laws against smoking affect the use of tobacco?
How are tobacco leaves cured or dried?
How has tobacco helped increase the government's income?
Does a confirmed smoker get positive pleasure from tobacco, or merely relief from the discomfort of craving it?

Picture Hunt

Where does tobacco come from? 9–221
Why are some tobacco plants covered with a tent? 9–223
Which state is famous for its tobacco? 9–224

Related Material

How does tobacco get its flavor? 2–20
How did tobacco influence slavery in this country? 7–123
What products did the Virginia colonists export to England? 7–123
How does the Internal Revenue Bureau of the Treasury Department collect taxes on tobacco? 7–377

Leisure-time Activities

PROJECT NO. 1: Watch a cigar maker at work, 9–222.
PROJECT NO. 2: Drop some tobacco crumbs into a jar of water containing a live goldfish and see what happens. Remove the fish in time to save it.

Summary Statement

The Indians smoked tobacco long before Columbus came to America. Europeans soon learned to smoke. Nicotine, the drug in tobacco, is a powerful stimulant to the heart, and if taken habitually, puts a great strain on it and other organs.

When the tobacco crop is ready for harvesting, the finest leaves are often cut and hung up on cords or laths for curing. Who would ever guess that these great leaves would ever make up the neat little cigarettes and trim cigars which so many people are fond of smoking?

Photo by Norfolk-Portsmouth Adv. Board

The WEED WE FOUND *the* INDIANS SMOKING

It Would Surely Have Been Better If We Had Never Found Out about Tobacco, for It Is Always More or Less of a Poison, though a Very Tempting One

SOMETIME when you see a friend smoking, ask him to let you hold a handkerchief before his lips while he blows a puff through it. You will find that the smoke has left behind it a dark stain, in which have been deposited various oils and a very tiny portion of a deadly poison called nicotine (nĭk'ō-tĭn). If a single drop of the poison is placed on the skin of a rabbit, the animal will die. Of course, before your friend exhaled the smoke a great deal of the oil and the nicotine had been spread over the passages of his nose and throat, and had had an effect on his heart and nerves. That is why smoking is always injurious to young people, and often to those who are grown. It is the reason why smokers frequently have a cough, and sometimes develop what is known as tobacco heart.

It is only lately in the history of the race that men have taken to smoking. The people of the Middle Ages knew nothing about tobacco, and it was not till after Columbus discovered America that white men ever saw the plant. But the Indians had known how to smoke for a long time, and they taught the habit to their conquerors. At first the white men had been a good deal startled to see the solemn braves "swallowing smoke" through a Y-shaped pipe, the stem of which they held in the smoke that rose from burning tobacco leaves, while they inserted the other two ends in their nostrils. This nose pipe the Indians called a "tobaco,"

and it is possible that from it the plant took its name, though it is said that in Mexico the plant itself was called "tobaco."

It was not until 1558 that a Spanish doctor brought the tobacco plant to Europe. In the next year Jean Nicot (nē'kō'), the French ambassador to Portugal, sent some seeds of the plant to the Queen of France; and from his name tobacco took its scientific name of "Nicotiana." Smoking is said to have been started in England by Ralph Lane, the first governor of the first colony that Sir Walter Raleigh planted on Roanoke Island. And it is Raleigh himself who is supposed to have introduced the "weed" to the English court. The story is told that on the occasion when one of his servants first saw his master indulging in the new vice, the honest fellow was so alarmed at seeing Sir Walter "on fire," as he thought, that he shouted for help and doused the knight with a pitcher of water.

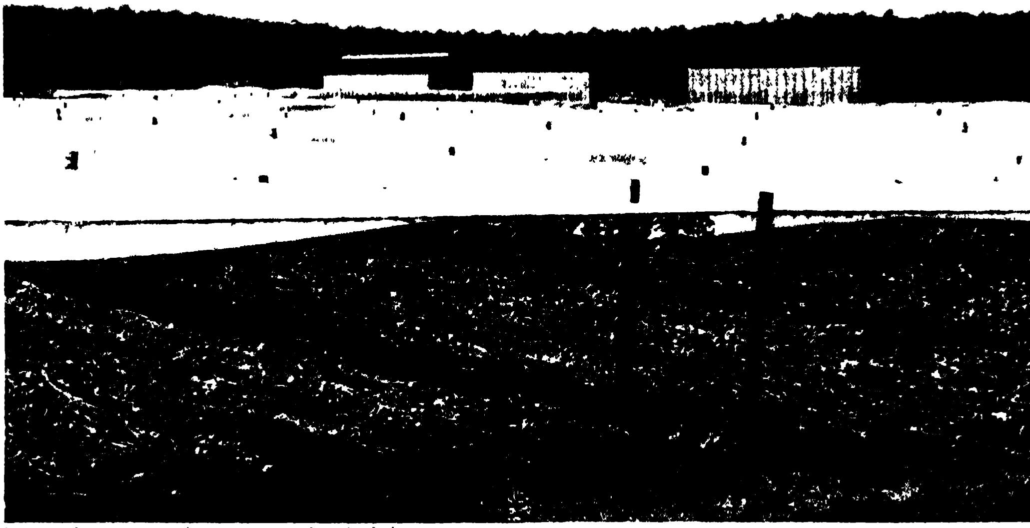
There was a good deal of opposition to the new custom. James I, the king, wrote a book against it, which he called "A Counterblaste to Tobacco," and the church threatened to put out of the fold anyone who indulged in the practice. Turkey went still further. There a smoker could be put to death. And yet the habit spread. People learned to smoke and chew and take snuff, a form of tobacco that has now gone out of fashion in most places. At present there are few regions in the world where tobacco is not used.

The quality of the tobacco leaf depends on many things: soil, weather, the care of the plant, the time of cutting, and the method of curing. And so delicate is the plant that if so much as a rusty nail happens to be buried in the soil close to the roots, the flavor of the leaf will be affected by it. That is one reason why there are so many different grades and varieties of tobacco.

The United States yields the best grades

Courtesy Farm Security Administration, photo by Marion Post

This tobacco waiting to be harvested is growing in an "open" field in Connecticut. The light-colored leaves in the background have already been harvested. They will be hung in clusters in the drying barn beyond.



Courtesy Farm Security Administration photo by Delano

The very choice tobacco just harvested from this tobacco field has been protected from sunburn by its billowing canopy of cheesecloth. The valuable leaves have been stripped off, leaving the bare stalks.

grown, though Turkey, Russia, Sumatra, and Cuba are all noted for raising leaves of superior excellence. Tobacco from those countries is still held in high esteem, but all their special varieties can now be grown in the United States successfully. More than a quarter of the world's tobacco is raised here. North Carolina, Kentucky, Virginia, South Carolina, Georgia, and Tennessee are the largest producers, and their product is favored for cigarette and pipe tobacco. Pennsylvania, Wisconsin, Ohio, and Connecticut lead in the North, and grow a leaf that goes to the making of cigars. All together we grow well over a billion pounds of tobacco a year, and sell the crop for many millions of dollars.

The World's Tobacco Plantations

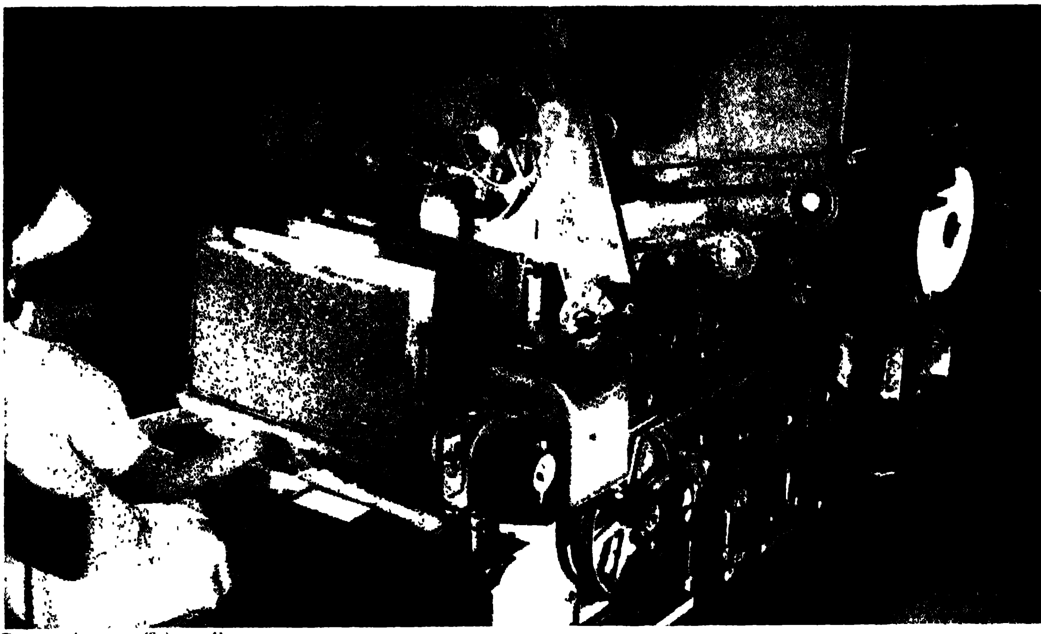
The world uses many millions of tons of tobacco a year, and Russia, Greece, Turkey, Japan, the Dutch East Indies, the Philippine Islands, India, Brazil, and Cuba all help largely to raise it. Germany, Great Britain, China, and France are the biggest buyers.

This money-yielding plant will grow over a wide range. All the way from Southern Chile and the Cape of Good Hope north to Canada, Norway, and Manchuria it flourishes; and it will grow in nearly any kind of soil, though of course with varying quality. In heavy clay soil the leaf is dark green, and when it is cured has a dark brown or reddish tint. In sandy soil the leaf is lighter in color—or "bright," as the grower says—and when cured is a light yellow.

How Tobacco Grows

Tobacco plants have to be started in a seed bed and then, in some two months, transplanted to rows in the open field. An acre will contain from ten to twelve thousand large, coarse-leaved plants. They grow to be from three to five feet tall, and taper toward the top, where they bear a long spike of tubular, sweet-scented flowers of pink or white. At the bottom the leaves, which are always sticky, will measure two feet or more in length, but they will be only a few inches long at the top. Some of the finer grades are grown in the shade, under screens or spreading trees.

After two months of careful cultivation in the field the crop is ready to be harvested. For high-grade tobacco the leaves are cut off one at a time as they ripen, and strung on



Courtesy American Tobacco Company

Machines like this one faster and more clever than human hands—help turn out the millions of identical cigarettes smoked in the United States every year. The upright frame standing on edge in front of the worker is being packed by her with cigarettes, all cut and ready to be slipped into their wrappers. This is one of the last of the many steps in the process through which the tobacco must go between harvest and market.

cords for curing. But usually the whole plant is cut, and five or six plants are strung on a lath to cure.

In the United States very little tobacco is now cured in the sun. Sometimes it is hung in barns, where the air can circulate freely through openings in the walls. For some six weeks it must hang there, and in wet weather fires must be lighted to dry the air. According to another curing process, the temperature in the barn is gradually raised to 150° F., and kept there for four or five days. Sometimes the temperature is raised still higher by means of steel flues that carry the heat through the barn from fires outside. This last curing process lasts only from three to five days.

After being cured, the tobacco is dry and brittle and cannot be handled without crumbling. So it has to be left in the barn until the weather has grown damp enough for the leaves to absorb moisture and become soft again. Then they are stripped from the stems, sorted into three grades according to quality, and tied into small bundles called "hands." After this they are stacked and allowed to ferment for a month—unless they have been "flue-cured," when fermentation is omitted. After fermenting, the leaves are again graded and packed, and stored sometimes for several years to age. This ageing is one of the things that gives good tobacco its fine quality. The best grades sell for many dollars a pound; the poorest for a few cents.

In some countries the manufacture of tobacco is carried on under government supervision; in others it is a monopoly, either of the state or of private corporations. Nearly all countries derive large incomes from its manufacture and sale. The revenue is usually collected in the form of a stamp tax. If you will examine a package of pipe tobacco, a box of cigars, or a package of cigarettes, you will see the revenue stamp across the top of the package, placed in such a way that the opening of the package will destroy the stamp. As a further safeguard it is stated on every wrapper that all persons are forbidden to "use this package for tobacco again." The government takes every means to safeguard this revenue.

HOW FOOD IS KEPT *in* CANS

Reading Unit No. 1

WHY DOES FOOD KEEP IN A CAN?

Note: For basic information not found on this page, consult the general Index, Vol. 15.

For statistical and current facts, consult the Richards Year Book Index.

Interesting Facts Explained

Things to Think About

How did the California gold rush help to develop the canning industry?
How have wars affected the canning of foods?
How did Louis Pasteur explain the preservation of canned foods?
Why are the exact temperatures and the cooking time important in the canning of food?
How has the canning of food affected man's diet?

Picture Hunt

Related Material

Practical Applications

Summary Statement

To can food, we first heat the food in order to sterilize it and then can it in order to keep it sterile.

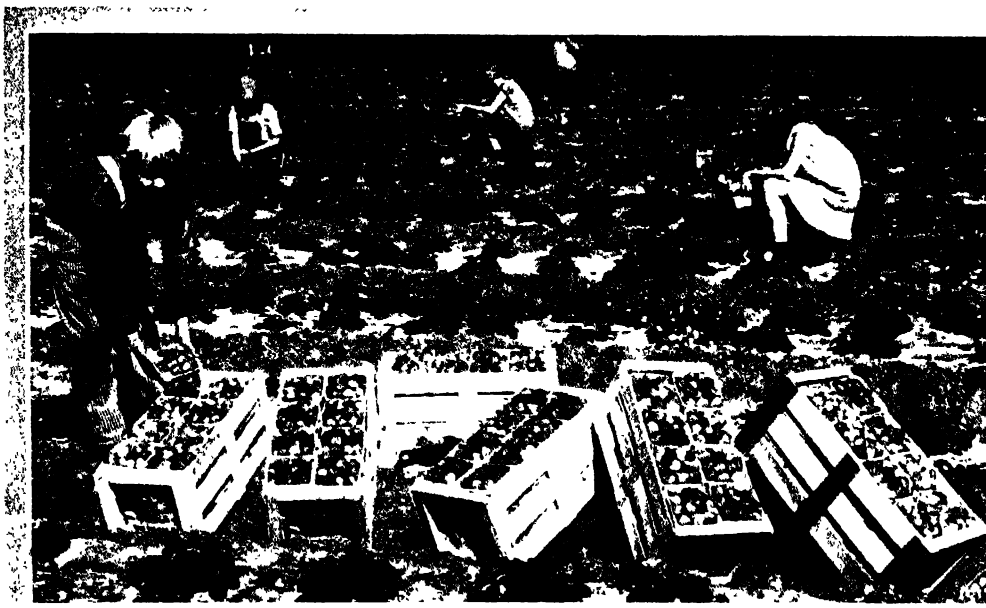


Photo by Sarasota Co. C. of C

In spite of all our machines, strawberries still have to be picked by hand; and these young people are glad to earn something by working during the harvest in the sunny Florida fields. Florida has thousands of acres of strawberries. Many of these red, luscious berries, of course, are eaten fresh at home or in distant cities and villages. But if we ate them all fresh, what should we do for strawberries in winter, or for strawberry jam to eat on our toast? The answer to that is that huge quantities of them are canned.

WHY DOES FOOD KEEP *in a* CAN?

A Hundred Years Ago Nobody Knew; but Now We Have Green Things on Our Tables All Winter Long

ANY kind of food at all will spoil if we just let it alone. And once it spoils, it is very likely to kill us if we eat it. The reason it spoils is that the tiny things we call bacteria (băk-tē′rĭ-ȧ) get into it, and grow and multiply by the billion. If we can only keep them out, the food will stay good. Now men have known a few ways to do this for a long time—long before they knew how to kill bacteria, or had any notion that there were such things as bacteria in the world. They just found out that food would keep longer if it was cold, or if it was perfectly dry So they would put it on ice, if there was any ice around, or would dry it out in the sun, if the sun was hot enough and the air dry enough. In that way we got our dried meats, for instance, like the pemmican of the Indians. But neither the Indians nor anybody else knew that the reason why food would keep on the ice was that bacteria cannot work in the cold, or that food would keep when dried because bacteria cannot work without water.

Now the great way to keep food was found out much later. That is by making it sterile (stĕr′ĭl) and then keeping it sterile—in other words, by killing all the bacteria in it and then keeping all other bacteria out of it. That is done by heating it for the heat will kill the bacteria—and then by sealing it up in cans to keep any other bacteria away from it. In a word, our great way of keeping food is canning.

We knew how to can food, too, a good while before we knew why it was that the food would keep in the cans. Nearly a century and a half ago a French cook named Appert (ȧ′pĕr′) stumbled on the fact that

if he heated food in some sort of jar and then sealed the jar tight, he could keep the food for a long time. That was the beginning of canning. But it was not till the great Pasteur (pàs'tûr') found out about bacteria that we understood why the food kept when it was heated and sealed up.

Since the day of Appert there has been no change in the basic principle of canning. But there have been all sorts of improvements—so many that Appert and his associates would stare in amazement if they could see what we are doing now. We have done a great deal of work, in government offices and in colleges and universities, to find out just how hot we must heat each kind of food to make it sterile, and just how long we must keep it hot. For different foods require different degrees of heat, and for different lengths of time; each one must have just enough heat to make it sterile, but not enough to cook it too much, and so ruin it.

We have also found out far better ways of applying the heat, and made far better cans to seal the food in; and we have learned a great many other ways of making sure that the food is sterile and then of storing it in vessels where no bacteria can possibly enter to keep it from staying sterile. We have discovered just when each kind of food must be canned; for some kinds must be canned almost immediately after they are picked from the stalk or vine, if they are to be good to eat, while others can wait longer. And most striking of all, we have made great machines to do nearly all the work for us, in prodigious quantities and at amazing speed. For all these reasons canning has now become a highly scientific industry, and one of the largest in the world.

Photo by the N

Men did not wait for someone to invent canning before they learned how to save part of their harvest to eat during the winter. The Indians, for instance, dried apples and carrots and corn and other things for future use.

Though it did not start in the United States, it is here that the industry has had by far its greatest growth. That growth is closely connected with certain great events in our history.

For instance, there was not a great deal of canning in America before the days of the great gold rush to California after 1849. There had been plenty of fresh food in most places before that. But when the gold seekers started on their long trips over the prairies, mountains, and deserts, they often found it hard to get food all the way, and some kind of food that would keep through the journey of months came into great demand. If the food was canned, it would take up only a little space, too, and space

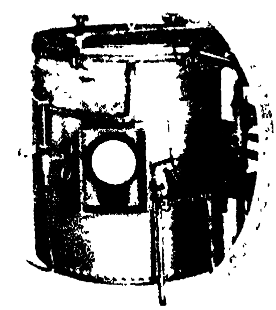
was at a premium; for there was room only for bare necessities in the bulging covered wagons that had to serve both as homes and vehicles on the long hot trip. Small wonder, then, that the demand for canned goods caused many a can-

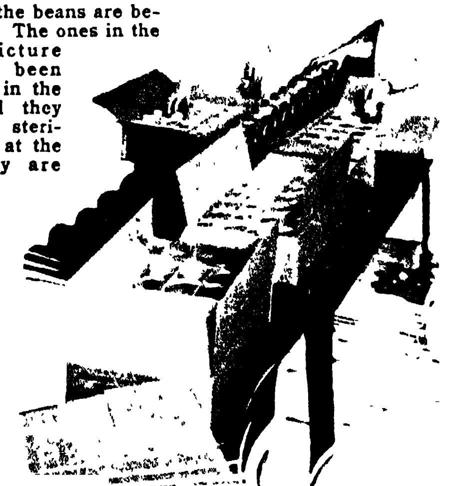
Only the favored trio of tomatoes, peas, and corn are ahead of baked beans in the American canning industry. We eat millions of dollars' worth of canned baked beans a year

nery to spring up in the East, the South, and the Middle West, and in time in the new towns on the Pacific coast.

Then came the Civil War in 1861, and a far greater demand than ever for canned food. The armies often had a hard time to get enough to eat, and the need was very great for vast quantities of provisions that could be carried quickly and easily, and always keep fit to eat in camp and on the march. So the canning industry grew to a vast size, and after the war it kept right on growing. More and more people got used to canned foods and to eating summer vegetables all winter long, more and more kinds of things were canned that had never been canned before, and better and better ways were found for keeping them good to eat. And America was far ahead of the rest of the world in canning.

She is still ahead. But now many of the other countries have come into the industry on a large scale also. For the World War from 1914 to 1918 showed all the world what the United States had learned at so much cost in her own war half a century earlier. With millions of men on the battlefields, every country in the world learned the value of canned food as it had never been known before; and canneries of huge size sprang up everywhere— in





On this page you will see baked beans in the process of being canned. In the large oval the beans are being sorted. The ones in the center picture have just been parboiled; in the small oval they are being sterilized; and at the right they are snug in their cans and are being labeled and packed for shipment.

Photos by Beechnut Packing Co.

England, in France, in Italy, and all over Europe; in Australia and New Zealand, in South America, in Japan, and in the Malay States. And after the war these and all the other countries that had learned how to can

on a large scale kept it up wherever there was a demand for their new canned foods. The result is that we are now getting far more kinds of food in cans from all over the world than ever before—fish and meat and fruits and vegetables of all kinds. We can have crab meat from Japan, sardines from France, pineapples from Hawaii, shad roe in the winter time, and all sorts of other things at any season from places near and far.

Of course no one ever said that things in cans are so good as they are when fresh. But they are often nearly as good, and sometimes they may be, though a little different, even better. That, however, is not the point. Of course we are going to eat fresh peas in the summer, at least if we live where they grow. The point is that it is also a fine thing to have peas all the winter too, or to have them if we live in some place where they cannot be raised. Very, very few of us will ever catch a sardine out of the ocean, but anybody can buy sardines at the grocery on the corner. And so with hundreds of other things. We shall always drink our milk fresh at home, but if we are going off into the wilds we shall be very glad to have canned milk—whether we take it along as a liquid or as a powder.

Photos by American Museum of Natural History and Swift & Co.

In colonial days many women, like the sweet old lady above, peeled their apples or peaches and hung them on the rafters or laid them on the roof to dry. And farmers then and now, as at the right, have soaked in brine the meat they wished to keep and then have smoked it.

Where Our Tin Cans Come From

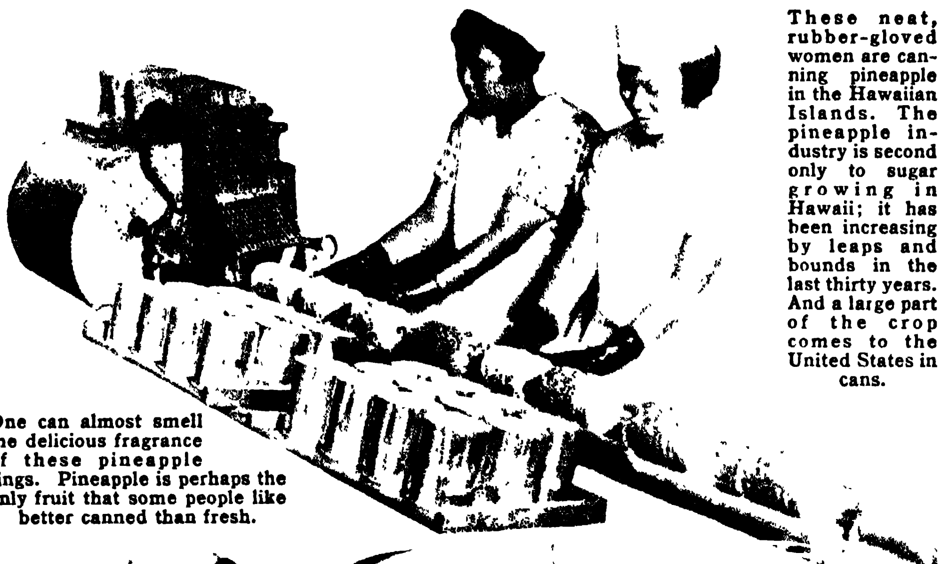
The canning industry is now so large that the making of the cans themselves has grown into a big business all by itself. In the old days they were all made by hand, and that was a slow and expensive process. The tinsmith would lay out a flat sheet of metal and cut it into strips with a pair of shears. Then he would roll up a strip of the right length, and put on a top and bottom. If he made fifty cans a day he was doing pretty well, and if all his cans were air-tight he was doing still better. Now the cans are all cut out and put together by machinery, which does the work better and far faster, and so lessens the cost a great deal.

Nearly every boy and girl has seen a little canning done at home and knows something about the secrets. But fairly few of us know what goes on at the big canneries that send us so many things to eat. So let us take one of the commonest things that we get in cans and see what happens to it in its trip from the farm to our table. We will take peas, which are sold in millions of cans.

If you know anything about peas, you know that they ought to be cooked at once after they are picked off the vine. Otherwise a great deal of the fine flavor is lost. In the same way they have to be canned at once, and therefore the cannery ought to be very near the field where they are growing. Even then they will get too stale if we send out people into the fields to pick off the pods by hand and bring them to the cannery in baskets. So we have made a machine to go out into the fields and pick them. It does not exactly pick the peas either; it cuts down the whole plant, and sends it in to the cannery.

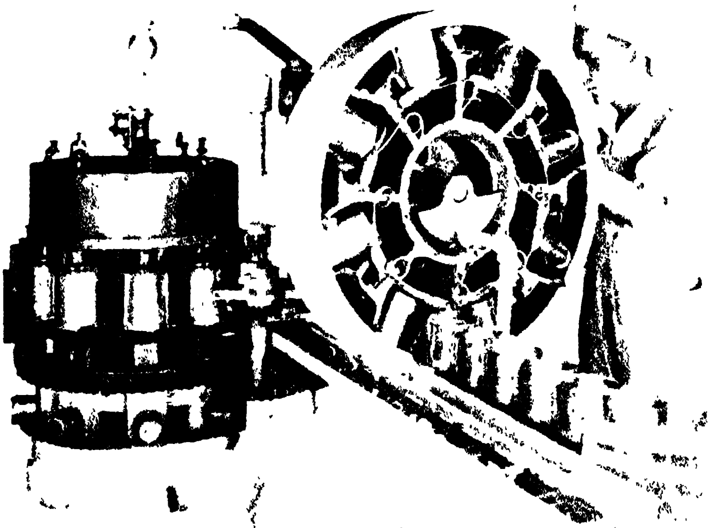
So great loads of the plants come in at once, each plant with a few pods on it, each pod with a few peas inside it. The whole load is dumped into another machine. This cuts away the stalk and leaves from the pods, and shells the pods themselves; and out come the tender little peas, all fresh from the farm. No hand touches them. They

HOW FOOD IS KEPT IN CANS

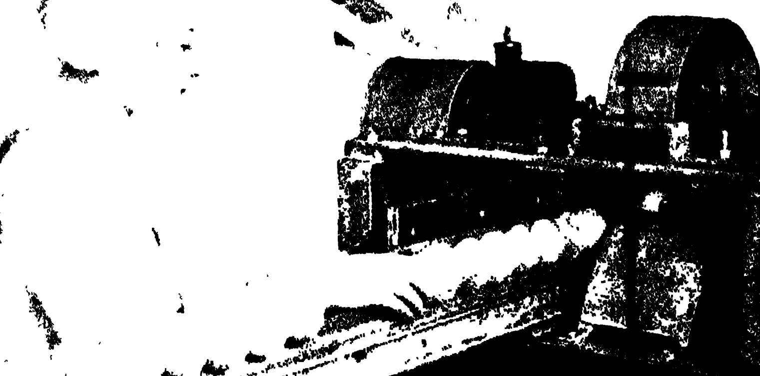


These neat, rubber-gloved women are canning pineapple in the Hawaiian Islands. The pineapple industry is second only to sugar growing in Hawaii; it has been increasing by leaps and bounds in the last thirty years. And a large part of the crop comes to the United States in cans.

One can almost smell the delicious fragrance of these pineapple rings. Pineapple is perhaps the only fruit that some people like better canned than fresh.



Different kinds of machines have to be invented for the canning of almost every different kind of fruit. Apples, for instance, are pared, sliced, and cored by machine, and peaches are peeled and halved by other machines, but pears usually have to be pared by hand. Almost all the development of these clever machines has come since about 1870.



A large part of each year's crop of peaches in the United States goes into cans. To the right is a machine for cutting the peaches into halves, and above is another for draining water and extra juice from the cans.

Photos by the Hawaiian Pineapple Co., Libby, McNeill & Libby

are all sorted out according to their size and quality, still by machinery. And then they are ready for canning.

The Modern Way of Canning

They are put into the cans and thoroughly sealed. Then they go, in their cans, into a great closed kettle, or retort, where they are cooked under steam to sterilize them. They must reach a certain temperature, of course, and stay in it for a certain time; yet they must not be cooked too long, or their flavor will be spoiled. So as soon as they have been heated long enough, they are taken out and cooled very rapidly, to keep them from going on stewing after they have come out of the heater. Now they are "done." A fine paper label is pasted over the can, with a picture of what is inside and the name of the factory, and they are ready to get on the train and go off to the grocery. We buy a can and take it home, open it and heat the peas once more. In five minutes they are on the table. Of course we ought to say that there are laws governing the whole process to protect us from bad canning; and everything we eat in cans must be put up according to the law.

This essential process is the same for everything we eat out of cans. Always it is just a matter of heating to sterilize and canning to keep sterile. But the details vary a good deal with the particular thing that is being canned. Of course what is best for peas may not be best for tomatoes—to say nothing of salmon! So for each thing we have a more or less different process, varying especially in the amount of heat applied and the length of time the food is kept under the heat. And any given thing may require some kind of special treatment—some things must be peeled, others must be seeded, some must be canned whole, while others must be sliced. Many may be put up in any one of several ways. We may have our peaches whole or sliced, our pineapples whole or sliced or cut into cubes. Almost always the whole thing is done by machinery.

In spite of all the great canneries, a good deal of canning is still done in the home. For although canned food is very cheap, there are thousands of housewives who think it is little short of criminal to let all the surplus fruits and vegetables of the summer go to waste instead of "putting them up" for the winter. Some of the housewives also like their own products better than what they can get from the factories. So there are many enthusiasts in canning in the little kitchens of the land, and many of them have attained great skill.

The War's Effect on Canning

During the war, when food was so scarce, there was a great deal of this, and many people took to canning who had seldom or never dreamed of it before. Many of them began to grow their own vegetables for canning, in any little lot that they could get in town or country. After the war many of them kept on canning, for thrift or fun or both. New tricks are all the while being invented in canning, contests are being held, and prizes and honors awarded to the best canners. The magazines for women and for girls are full of information on up-to-date methods, and advice and assistance can be secured from the Coöperative Extension Service of the United States Department of Agriculture. There is no reason why anyone should not have a pantry shelf full of fine products made right at home.

No one can say to what extent canned goods will be replaced by dehydrated (dē-hī'drā-tĕd) foods, of which vast quantities and an amazing variety were manufactured for shipment overseas to the armed forces. Dehydration, or the removal of water from food by mechanical means, greatly reduces the food's bulk and so saves space and money in shipping. One pound of meat shrinks to four ounces and three dozen eggs weigh only a pound, for all but 4 or 5% of the original moisture is removed. In fact, foods dehydrated by means of electrons—or radio-frequent energy—retain only 1% of their moisture. That method is much quicker than the usual process of dehydration by blasts of hot air; so the food does not lose so much in flavor, color, and vitamin content. To serve a dehydrated food it is necessary only to add water to it and cook it for a short time.

Reading Unit No. 2

INSIDE A BIG FLOUR MILL

Note: For basic information not found on this page, consult the general Index, Vol. 15.

For statistical and current facts, consult the Richards Year Book Index.

Interesting Facts Explained

What plant products can give us flour? 9–233
The mortar and pestle—the first flour mill, 9–233
Early grist mills, 9–233-34
How is grain shipped to a modern flour mill? 9–234
Cleaning wheat grains, 9–235-36
Bleached and unbleached flour, 9–236
Whole-wheat flour, 9–236
Flour-milling centers of the United States, 9–236

Things to Think About

How is flour milled very fine?
Why is Minneapolis a leading flour-milling city?
Why are different kinds of flour milled?
What is the difference between modern and primitive methods of removing the husk?
If people ate only whole-wheat flour, would they come to prefer it to white flour?

Picture Hunt

What are some of the primitive methods of making flour? 9–233-35
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How is wheat harvested? 9–97, 100, 105
How was wheat grown in the New Stone Age? 5–35
What diseases attack wheat plants? 9–100, 2–138, 140
How many kinds of wheat does man grow? 9–98, 100
How is wheat traded? 7–505
Why is wheat called a grass? 2–179
How does soil affect plant growth? 2–41-43

Leisure-time Activities

PROJECT NO. 1: Make a waterwheel, 9–233, 1–370, 505, 10–398.

PROJECT NO. 2: Grind some grain into flour between two flat stones, 9–234.

Summary Statement

For thousands of years man has been eating bread; so man has had to manufacture flour. Ancient flour was coarse and was called meal; modern flour is a much improved product.

Photo by Anderson Rome

This pleasant view of rural England shows you an old flour mill made of stones and creaking boards, crowned with a roof of thatch. The sparkling stream pauses on its way to the sea to turn the water wheels, so that the miller may grind his sacks of wheat and supply the villagers with flour.

INSIDE *a* BIG FLOUR MILL

The Story of How the Golden Grains of Wheat Are Turned into Smooth White Flour to Make Our Bread

OR thousands of years men have been eating bread; so for thousands of years they must have been making flour. For you cannot have bread without flour, or at least without meal, which is only a coarse sort of flour. And that means that another amazing chapter has to be written in the story of our bread, to fit in between the chapter on wheat and the chapter on bread itself.

So many kinds of flour, made from so many kinds of wheat—not to mention rye flour and potato flour and rice flour and bean flour and the other kinds not made of wheat at all! So many rollers and sieves and ingenious devices! But we have not come to all that as yet; first, we should think back to the way flour used to be made long ago.

The first flour mills were merely the simple combination we call mortar and pestle. The mortar was perhaps a hollow stone, the pestle another stone with which the grain in the mortar could be pounded. With a mortar and pestle the Indian squaw beat her Indian corn into coarse meal much as the Egyptians must have beat their wheat thousands of years ago.

Next came a stone gristmill rather like a grindstone. There would be a large flat stone on which the grain was spread. Another stone, heavy and shaped like a short log, would be rolled over the grain to crush it. In time men worked out a way to harness oxen to the mill and let them move the roller. Thus the mills grew larger and the flour better because more finely ground.

From harnessing oxen men turned to harnessing water to do their grinding. Mills arose by every singing little stream that would busy itself turning the mill wheel. Until half a century ago the jolly miller with his floury cap and the mill "down by the old mill stream" were among the most familiar things in life, as in song and story. In lands where water power is scarce men harnessed the winds instead of the waters. What would Holland be even to-day without its windmills with their enormous whirling arms?

In many parts of the East, the natives still cling to their primitive ways of grinding flour. That is what the Turkish women in the topmost picture are busy at. The Chinese in the oval is grinding rice. And to the right are two young millers of Japan.

by Visual Edu Service and Pr os, Berlin

The grinding in these old gristmills was simple enough. The wheat was ground between two large millstones and then sifted to remove the bran, which is the outside shell, and the "shorts" or "middlings," which are too coarse for flour. The mill often bought the wheat right from its neighbors, and sold them back the flour. Many a farmer's boy went to the gristmill with a few bags of wheat in a light wagon, or with one bag on horseback, and returned with flour for his mother to bake into bread and pancakes

A Glimpse of a Modern Flour Mill

But the days of such simple milling are pretty well over. The great flour mills of Europe and America to-day are a very different matter.

The modern mill will be a great building eight or ten stories high, and the grist will start its milling adventure on the top story as grains of wheat, and end it on the bottom story as finished flour. The wheat will be bought in carload lots instead of from the neighbors and the flour will be shipped away to stores and bakeries instead of being carted home behind the family horse. Such a complicated process of milling done with so many clever machines would surely make the old-time miller gasp!

First, of course, the wheat has to be thoroughly cleaned. This is not so easy as it sounds, on account of the groove down the side of each grain, in which dirt has a way of collecting. One sort of cleaning machine has a scouring surface covered with emery. Then after various adjustments of temperature and moisture called "conditioning" or "tempering," the long and difficult process of grinding begins.

The reason that the new way of grinding is so long and difficult is that people are no longer content merely to *crush* the grain of wheat, grinding up a good deal of the husk along with the kernel. Nowadays the idea is not to crush the grain at all, but gradually to break it up into tiny particles, and to sort these particles into different grades of flour according to how fine they are and how little husk there is in them. This idea of breaking the wheat up gradually instead of mashing it was first developed by the Hungarians a good many years ago. The old process was very bad for the particular kind of wheat they grew. When farmers in the western and middle-western parts of Canada and the

INSIDE A BIG FLOUR MILL

Photo by India State Ry

Around and around, with slow and steady pace, march these patient cattle of India, turning the mill which grinds the grain into coarse flour. How different this scene is from the one below!

Photo by Washburn Crosby Co.

This modern American flour mill might better be called a "flour factory." Here are row on row of the neat and skillful machines which turn the farmer's wheat into fine, soft flour.

United States began growing wheat rather like the Hungarian wheat, we too had to use the new method of grinding.

First the grain goes between a series of pairs of rollers called "breaks," which take off the husk or bran. In each pair of rollers, one goes faster than the other, for that sort of movement does not crush so much. The earlier rollers are usually fluted or corrugated, and this unevenness also helps to break off the bran without crushing the grain.

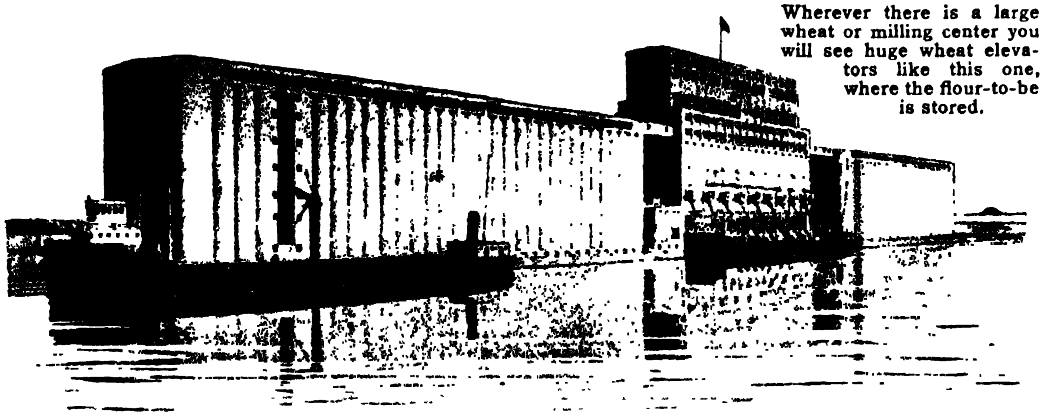
When the grain has gone through the breaks—from three to six sets of them—there is a certain amount of bran, a little flour, and a large amount of what the millers call "middlings," or half-ground particles. The middlings now go on to a fresh set of rollers, which keep right at the task of breaking up without crushing. Sometimes before the flour is finished it has gone through as many as fourteen sets of rollers all told. Between grindings it goes through "bolting" machines, which sort the particles according to size, usually by sifting through cloth. Then there is a process called "purifying" which sorts the flour particles according to how firm and solid they are.

Some kinds of wheat make flour that is quite yellow, and as people seem to prefer their bread white, millers have tried to work out ways of bleaching the yellow flour. But no one seems yet to be altogether sure whether or not bleached flour is good for us. So different countries have made laws about it; in the United States all bleached flour has to be labeled "bleached."

And now our flour is ready to go to the packing rooms, where it is put up in bags of various sizes to be started on its journey to our kitchens. Much flour used to be put up in barrels, each weighing 196 pounds, but we seem to prefer bags nowadays.

We eat an enormous quantity of wheat flour, besides a good deal of rye flour and a little of various other kinds. And of the different grades and sorts of wheat flour there is no end. Each different kind of wheat makes a different kind of flour; and so does each degree of fineness in grinding and each degree of freedom from bran. Sometimes we like 100% wheat bread, with all the bran left in; oftener we like less bran; oftenest of all we like no bran at all. Crackers take different flour from bread. We even make self-rising flour that needs no yeast or baking powder to make it rise.

More flour comes from Buffalo than from any other city in the world. Minneapolis is a busy miller because of the water power furnished by the Mississippi. A single company, which started in 1866 with a mill that ground three hundred barrels of flour in a day, now turns out many thousands of barrels a day and ships to all parts of the world. Other American cities, too, are great milling centers Chicago, Milwaukee, St. Louis, Detroit, Indianapolis, Rochester, Toledo, Kansas City. Much of the flour goes abroad, of course. But though we do not eat up so much flour per person nowadays as we used to before 1900, each of us can still account for some 170 pounds every year.



Wherever there is a large wheat or milling center you will see huge wheat elevators like this one, where the flour-to-be is stored.

Photo by Canadian Gov.

HOW OUR BREAD IS BAKED

Reading Unit
No. 3

WHAT HAPPENS AT A BAKERY

Note: For basic information not found on this page, consult the general Index, Vol. 15.

For statistical and current facts, consult the Richards Year Book Index.

Interesting Facts Explained

What is the importance of bread? 9-238
How old is bread making? 9-238-39
Hardtack and matzoth, breads that keep forever, 9-240
Who were the first people to bake white bread? 9-240
Community bakeries, 9-241
How is bread made under absolutely sanitary conditions? 9-241-42
The flour that goes into different kinds of breads, 9-243

Things to Think About

Why is yeast put into bread dough?
What is happening to our knowledge of homemade bread?
How did the Egyptians knead bread?
How did the American Indian make flour from acorns?
Would people like bread better if it were sweetened, as cake is?

Picture Hunt

What are some early methods of baking bread? 9-238, 241
What is the commercial method of baking bread? 9-242

Related Material

What is the food value of flour? 9-102, 236
How many kinds of flour do people use? 9-233, 236
Where are the flour-milling centers of the United States? 9-236
How do plant diseases affect our supply of flour? 9-100, 2-138, 140
How are machines used to make bread? 10-533
What is breadfruit? 9-196, 212, 2-151
How does a lump of dough take the shape of a loaf of bread? 2-74
How is potato flour made? 9-144

Practical Applications

How is bread made light and fluffy? 9-243
How is it possible for millions of people to get fresh bread every day? 9-243

Summary Statement

The recipes of many lands are used in bread making. We do not ordinarily think of the importance of bread; yet it is the "staff of life."

In certain parts of Quebec the French-Canadian farmers still bake their bread in great outdoor ovens like this one. It is so big that the bread maker, as we can see from the picture, has to put her loaves in on a sort of shovel.

Photo by Canadian National Rys

WHAT HAPPENS *at a* BAKERY

Have You Any Idea of How Many Different Kinds of Bread Are Eaten All over the World, and of What Different Things Go into the Making of Them?

PEOPLE have been eating bread for so many centuries that they have come to talk of "bread" and "food" as being almost the same thing. They pray for their "daily bread," and speak of the "bread winner of the family" and "working to earn one's bread." They have even given the poetic name of "the staff of life" to this commonest of all foods.

When most of us speak of bread we think of sweet-smelling, fluffy loaves of wheat bread, golden brown without and white within. But there are and have been so many different kinds of bread that we could never count them all. For we call by that convenient name any food made by mixing some kind of flour and some kind of liquid into a dough which is then baked. And there is no end to the kinds of flour people have used, or to ways of mixing and baking the dough.

Men seem to have started making bread way back in the Stone Age, at the very dawn of civilization and long before any histories were written. We know this because we have dug up at certain places in Switzerland bread-cakes made of coarsely ground grain, hardened by the passing centuries. In the same places we have found large stones that look as though they must have been used for grinding the grain into flour, and also for baking the cakes. Probably what those antique lake dwellers did was to crush their barley and wheat as well as they could by hand between stones, knead their dough, lay it on a heated stone, and cover it with hot ashes. Perhaps sometimes the baking stone was convex—or humped in the middle—and thus thrust the heat right into the center of the cake. Dried cakes have been found in old Egyptian tombs which are hollow, or concave, as if they had been baked on such a stone.

HOW OUR BREAD IS BAKED

There are plenty of primitive peoples still baking their primitive breads right now, and many are the queer and clever things they do. Wild grains, nuts, and acorns—whatever grows about them without having to be cultivated—will give the savages their flour. The early natives of the West Indies used to make flour from the crushed roots of the manioc (măn'ĭ-ŏc) plant, from which we now make tapioca. African tribes still use the yams that grow about their huts. Among the American Indians, the Iroquois, the Dakotas, and other tribes who lived where the oak tree flourished used to make their flour of acorns. The careful squaw would choose the sweetest kinds, those from the chestnut oak or white oak if she could get them. These she would take out of the shell; then she would split the meats, and let them dry in the sun. She made the flour, as had the ancient lake dwellers, by pounding the nuts between stones, or else she used a crude homemade bowl and pounding implement, called a mortar and pestle. Many Indians still make this acorn bread.

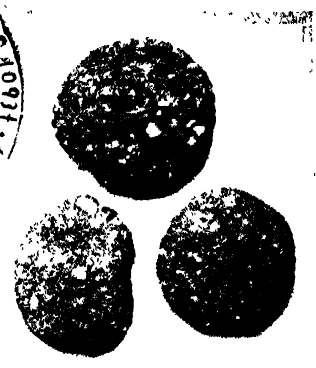


Photo by American Museum of Natural History

These are not pebbles, but loaves of bread thousands of years old which have been found in Egyptian tombs. The round seal to the left of them was sometimes used in early Christian times to stamp the loaves.

The Indians can show us queer and clever ways of baking their bread. The Iroquois or Dakota squaw who has just ground her acorn flour will knead it into dough and bake it, perhaps in an oven that is really a pit in the ground, perhaps in one built above ground of dried earth, perhaps in no oven at all, but merely by putting a hot stone in the middle of it. Another Indian way of baking is to roll the dough, this time made of corn meal, in leaves to keep it clean, and then to bake it—just as we like to bake potatoes on a a picnic—right in the midst of the hot coals. The Hopi Indians bake their "piki," a bread they consider especially delicious, by spreading it on a hot greased stone, as you might spread a pancake. The Pueblos and Zuñis learned from the Spaniards to build a small oven by plastering sun-dried mud cakes into the shape of a small cone-shaped beehive. They heat it first by building a fire *inside* it, then rake the fire out and put in the bread.

From the earliest times we know anything about, civilized peoples have been grinding flour and baking bread. And for thousands of years they have known what these savages do not know—how to make leavened, or raised, bread. For all

How would the women of New York City feel if, instead of buying their bread at the grocery, they had to make it out of home-ground corn, like this Indian woman who lived on Manhattan long before our day?

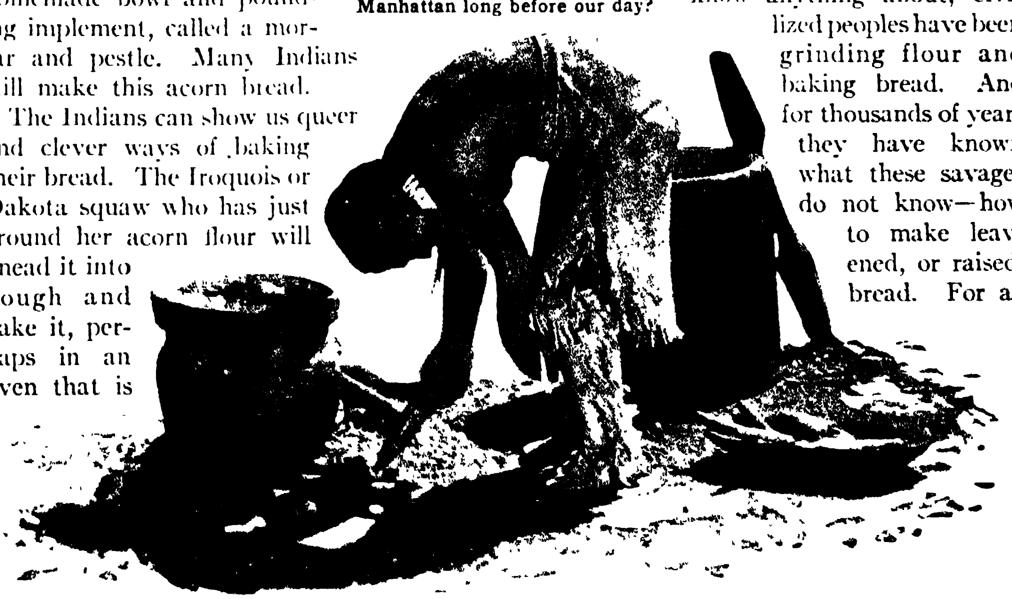


Photo by Metropolitan Museum of Art

Photo by Field Museum

These queer-looking outdoor earthen ovens in Mesopotamia are perhaps the oldest bakery in the world. It need not surprise us to find them there, for oldest things, when they are not in Egypt, are very often to be found in that other cradle of civilization, the valley of the Tigris and Euphrates rivers.

the different kinds of breads belong to one or the other of two great classes—they are either leavened or unleavened. If a bread contains yeast or baking powder or anything else that will make it "rise"—that is, puff up and become porous and fluffy—it is leavened. Most of the ordinary bread we eat is of this sort. Unleavened bread contains nothing to make it rise, and is consequently heavier and harder. This kind of bread is perhaps not so pleasant to eat, but it keeps almost forever and is a great boon to soldiers, sailors, and explorers. "Water biscuit" is unleavened bread; so is hardtack; so is the Jewish passover bread, called matzoth (mät'sōth).

The Bakers of Other Days

We know that the Hebrews of Old Testament times made both kinds of bread; otherwise the Bible would not contain those passages about unleavened bread which have been the reason for the eating of matzoth all these centuries. We know, too, that the ancient Egyptians were great bread makers. They had the queer and rather distressing habit of kneading the dough with their feet, as we hear from Herodotus (hē-rŏd'ō-tŭs), the great Greek historian; this habit, as a matter of fact, has been common here and there among simple peasants until very recent years. The Egyptians used various grains for their flour, and even made white bread, though it was only for the rich. Long before the time of Christ a small hand mill for grinding flour and an oven for baking bread were to be found in many a Greek or Roman home. Public bakers seem to have appeared in Rome in the second century B.C., and all sorts of laws and regulations had to be made for the making and selling of bread.

In the Middle Ages, life outside the little cities centered about the manor house where lived the great lord; and though the peasants tilled the ground and raised the grain, they were literally dependent upon their lord for their daily bread. For grain was always taken to the mill at the manor house to be ground into flour, and bread was always baked in the manor house oven. And you may be sure the grain was not ground and

Photo by Anderson, Rome

This bakery at Pompeii, in Italy, lay hidden for centuries after the great volcano Vesuvius had buried the city. Now that it is uncovered at last, it has much to tell us of how the ancient Romans baked their bread. In the background at the right you will notice a stone mill for grinding the flour by hand. Until not very long ago all our flour was ground by "stone burrs," or grinding mills made of stone.

the bread baked for nothing! No, the lord took a certain part of the grain and a certain number of the loaves for his share. It was a right which he very much prized—and too often abused, as many a tale makes clear to us.

The Origin of Community Bakeries

As time went on, another system of milling and baking grew up. Each little community in the country, often each little neighborhood in town, came to have its own bakehouse, sometimes also its own mill—for as you have noticed by now, milling the flour and baking the bread were until very recently almost as inseparable as twins. Where there was such a central bakehouse, it was an easy matter to mix the bread at home and take the dough there to be baked. This custom lasted almost down to our own times. To this day many European peasants are afraid to eat hot bread—probably because in the old days they had to leave their loaves at the bakehouse till they had been cooled and weighed.

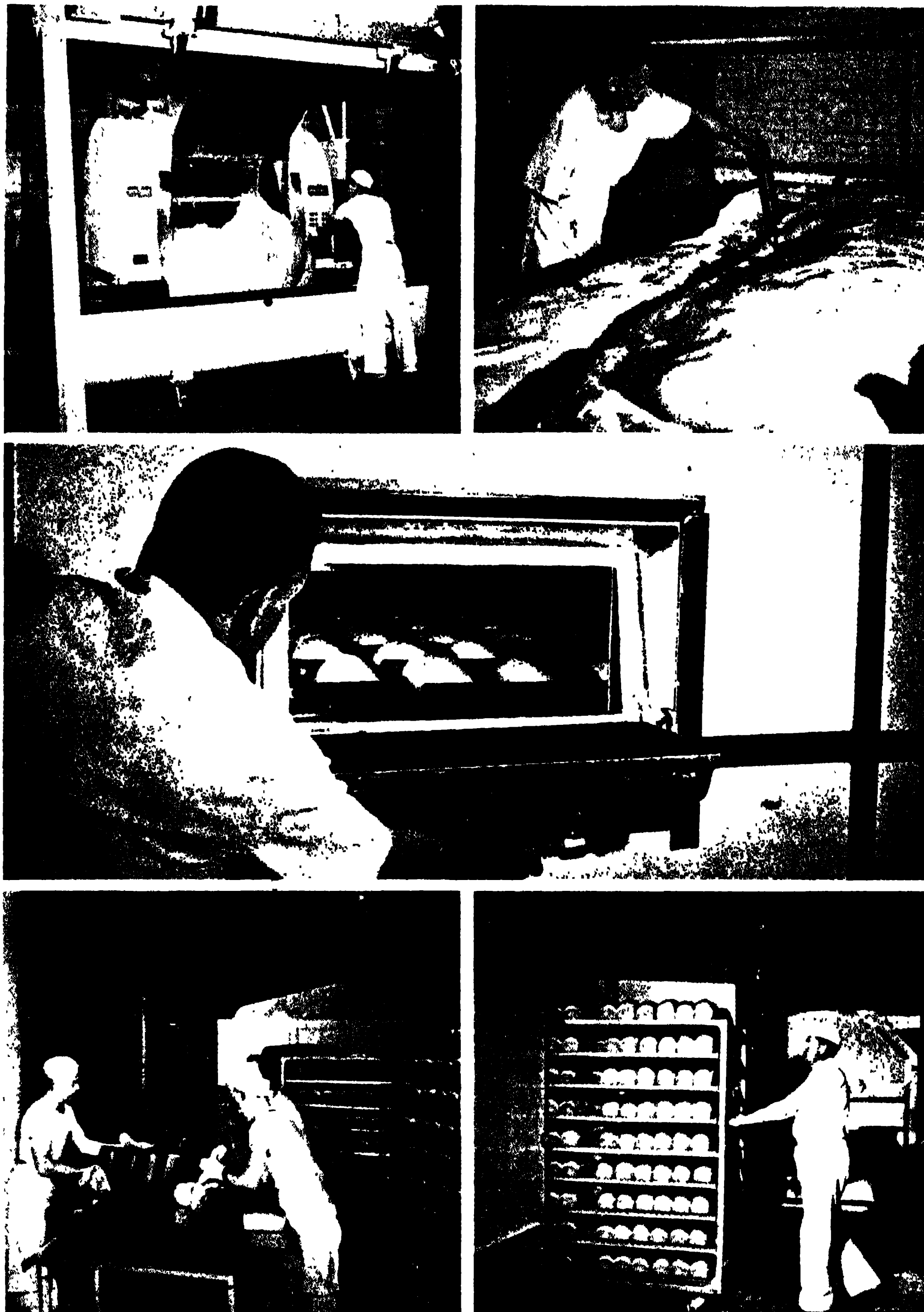
The invention of the stove was one of the things which brought in the custom of baking bread at home. And of course, so far as America is concerned, for a long time there was no other way of getting it baked at all, since so many people lived pretty much by themselves in a sparsely settled country. The old system of central bakehouses never grew up in America; but nowhere has there been a greater development of the system of public bakeries. This is a very old system, too, as we have seen: there were public bakeries in Rome two thousand years ago at least, and all through the Middle Ages the towns were always passing laws to regulate the sale of bread. But never before had there been anywhere near so much bread baked for sale as there has been since we learned how to make it by machinery—especially in America.

A Modern Bakery

If you go to-day to one of the giant bakeries which are scattered all over the land, you will see that the loaf of fluffy white bread you cut at lunch was not once touched by human hands—much less human feet as in ancient Egypt!—until someone in your own house took off its oil-paper wrapper and put it on the table. The genii of the machines did it all. The genii have human attendants, of course, but none of these attendants touch the flour or the dough or the finished loaf.

On the top floor of the baking plant are the different kinds of flour which the bakery has bought in carload lots and left to "mature," or age, for a few months before using. Just the right quantities of each kind are

HOW OUR BREAD IS BAKED



Courtesy Continental Baking Company

Baker's bread never varies, as home-baked bread does. Every process in its making is carried out with the greatest precision. Giant mixers like the one in the picture at the top left can handle so great a quantity of dough that the batch does not suffer from slight variations in conditions. In the picture on the right the dough is rising and is being tested for temperature. In the center, the neat loaves are in the baking oven. Below, left, the baked bread is coming out of the hot tins, and, right, is on its way into the cooling room.

then mixed together in the blending machine, and each blend is stored in its own hopper for its own particular use. When it is to be used, the flour passes through an automatic sieve, which takes out lumps as well as we could ever do it with our little hand sifters, and at such a speed as only the genii of machines can attain. The sifter passes the flour to the weighing machine, which automatically cuts off the proper amount and drops it into the kneader.

Machines That Make Our Bread

Here water at exactly the right temperature is added—automatically—to the flour, and at the same time the other things that go into the particular kind of bread that is being made are added. The yeast goes into the dough here, and a little sugar and salt, and usually some condensed or dried milk to make the bread richer and more nourishing. Then long steel arms stir and mix all these things thoroughly together. This machine is the oldest of the baking machines; its earliest form goes back to a French invention of the middle of the eighteenth century.

When it has been kneaded enough, the dough passes into the "dough room," where the yeast in it can grow and push out gases through the mass and so make the dough light and porous. While it is there, the machine genii punch it now and then to let the gases move more freely, and keep track of the heat to see that it remains always just right. Then, when the dough has risen enough, they push it out, dividing it into exactly even pieces as they do so. The automatic divider passes the pieces of dough, each now weighing either one pound or one pound and a half, on to the "rounding-up" machine, which pats them into shape. The rounder-up passes them on to the "proofing" room, or the room for the second rising, through which they ride on slowly moving trays. Then another of the genii, a moulding machine, seizes them and rolls them into the shape of loaves, all ready for the oven.

The loaves do not stop moving, in most big bakeries, even when they reach the oven. For the machine genii work better with a "traveling oven," that is, one in which the "hearth," as it is called, or the tray on which the loaves stand, moves from entrance to exit, or from the door around and back to the door, in exactly the length of time it takes to bake the bread. As the loaves come out of the oven, another piece of machinery turns them out of the bins to cool, and then the last of all the genii neatly wraps them in wax paper, ready for the market. So we may be sure that the bread we buy comes to us scrupulously clean.

This is the way most of our bread is made. The industry in the United States is the second largest of all food manufactories. It has built up great chain organizations with bakeries in many places, and worked out a system by which our corner groceries are kept always supplied with bread just out of the oven. It has meant that fewer and fewer Americans know anything about "home-made" bread, or the "bread that mother used to make."

The Flour That Goes into Our Bread

And unless you are an extraordinary cook, you will certainly get most of your "fancy bread" from the bakery. We have been talking mostly about white bread, because Americans eat more of that than of any other kind. But we often like graham or whole-wheat bread, too, made with nearly or all the wheat grain, as white bread is not. And from Europe we have been learning, in recent decades, to like bread made of other flours—rye, which is more popular in Germany, for instance, than is wheat, and barley, and even potato. Corn we have always known in "fancy bread," and the cornbread of the South is famous everywhere. In the Orient rice flour is the favorite. All these breads seem "fancy" to us because they are different. But for many generations our white bread has seemed the fancy kind to most people, since it uses only part of the wheat and has been more expensive than the "black" breads eaten by foreign peasants.

The real "fancy breads" are special kinds that take special preparations. And how many kinds, fancy or not, we can buy at a modern bakery! Breads made after the recipes of many lands—we really do not know until we begin to think about it how much we lean on our "staff of life."

Reading Unit No. 1

THE WEALTH OF THE GREAT WOODS

Note: For basic information not found on this page, consult the general Index, Vol. 15.

For statistical and current facts, consult the Richards Year Book Index.

Interesting Facts Explained

Making planks from logs, 9–245-46
Roads of ice, 9–248
Driving logs to the sawmill, 9–251
Log jams, 9–252
Hard and soft woods, 9–257-58
Lumber trees, 9–258
Conserving the forests, 9–257

Things to Think About

Why should new trees be planted after an area of trees has been turned into lumber?
How is lumber kept from warping?
Why is pine the most popular wood?
How are logs handled in a sawmill?
Why is metal often painted to look like wood?

Picture Hunt

Where are giant trees found? 9–245, 247, 250
How are logs shipped? 9–251, 253

Related Material

How is wood used as a building material? 9–375-76
How were early sailboats constructed? 10–140
How are forests being preserved, and protected against forest fires? 9–257, 2–241-47
How is artificial wood made? 9–294
What is the source of cork? 9–296-98
How is paper made? 9–275-80

Practical Applications

How are hard woods used? 9–258
What are the uses of cedar? 9–258

Leisure-time Activities

PROJECT NO. 1: Collect and mount samples of different woods which grow in the United States, 9–258.
PROJECT NO. 2: How to make a workbench, 14–29.

Summary Statement

Without the mighty forest roots to hold the soil together, rain water and melting snows would run off so fast that most of the world would be a desert. The forests supply us with all the wooden things we build and use.

Photo by U. S. Forest Service

A great tree represents Nature's tireless effort over a period of many years. This giant that was felled in Yosemite National Park, in California, started out in life before the birth of Christ.

The WEALTH *of the* GREAT WOODS

This Is the Heroic Story of the Way We Rob the Forests of Their Lumber and Bring It to Our Mills

MOST of us never see the mighty forests of the earth, but all the same we could hardly keep alive without them. In the vast meshes of their rootlets they hold the water that comes down in rain, and feed it steadily into the great rivers that keep our lands fresh and green. For without the mighty forests the water would run off to the ocean far too fast, and most of the world would be a good deal like a desert.

Out of the forests, too, have come many of the most precious things we own. The first home of man was in the deep woods. There the trees protected him from storms and hid him from his enemies, there they gave him fruits and nuts to eat. There the first rude huts he ever built were made out of the branches, bark, and leaves of the smaller trees, broken up and put together by hand—for as yet he had no tools to work with. His first tools were made out of the wood too, and for a long time after he found out how to make and use a fire, his only fuel was dead trees.

And what a list of things we still get from the great woods! Lumber, paper, fuel, posts and ties, fruit and nuts and sugar, cork and rubber, turpentine, resin, alcohol, fabrics and plastics—these are only a few of the things that come to us out of the woods. Of all these things we are now going to talk about a single one—the vast quantities of lumber that come out of the forest to make all the wooden things we build and use.

Every piece of lumber we ever see has been cut out of the round trunk of some tree at a sawmill somewhere. Many of us have seen how the great circular saws, driven by powerful machines, eat their way with many a whine and drone through some giant trunk from the forest and turn it out in smooth flat planks ready to put up into a house. That is all very merry work, and very rapid. But how did the great trees get out of the forest to the sawmill in the

first place? Who cut them down and hauled them out of the wild depths of the woods?

In the golden days of lumbering there was no railway into those depths, and hardly anything that we could call a road. It is those golden days that we are going to tell about first. So we must go back to some time about 1870, and to some place like Maine, Michigan, Wisconsin, or Minnesota—the great lumbering areas of that day. These regions had the finest stands of white pine that the world has ever seen, or will ever see. We may as well begin in Wisconsin, a state which long held the lead in lumbering. So let us start out for a great lumbering camp—or "logging" camp—around the headwaters of the St. Croix River.

Photo by American Lumberman

This is one of the old lumber camps, as they used to be built in the heart of the big woods.

We must set out as the winter comes on, for we do not cut down timber when the sap is running. It is going to be pretty cold, for the winter is a real one in these regions—some days it will be down to forty below zero. We are going to walk. The best road is hardly more than a trail through the woods, and often it is nearly impassable. The horses will have work enough to bring along all the food for the winter in the wilds —and we shall need plenty!

Up in the Big Woods

If we can make twenty miles a day we shall be doing well. In due time we shall get to the big logging camp. We find it in a good spot, with plenty of spring water, and the buildings are all ready for us. For the summer before, a crew of workers have gone out under a skillful foreman to put everything in shape. They have cut down enough trees to build the houses for the men and for the horses and oxen; they have made hay for the animals out of the natural meadows; and they have laid out the kind of roads that we shall need for dragging off our logs to the river. The camp is now stocked full of food, and we all settle down for the winter. The snow will come soon, and it will lie several feet deep till spring. We will forget all about civilization for a few months.

There are six buildings in our camp, all made of logs, with openings for doors and for a few windows. The spaces between the logs are chinked with bits of wood and moss, and plastered over with a yellow mud made of clay. The roof is low and flat, and covered over with thin strips of wood, called "shakes," which have been split out of some of the logs. The floors may be laid with wood, or they may be simply smooth, hard dirt. There is a little rough furniture—tables, benches, and bunks —all of it made on the spot.

An Old-time Logging Camp

Here is the shanty where the workmen sleep. It is about sixty feet long and twenty feet wide. All along the walls is a double row of bunks, one above the other, to sleep in. These are built out of split hickory poles, and look like big, shallow boxes filled with hay or balsam boughs and covered with blankets. Right in front of the lower bunks is a long bench called the "deacon seat"; and out in the middle of the room sits a big stove.

Next is the cook shanty, with a dining room about the same size and shape as the sleeping shanty. Here we find two long tables made out of heavy boards and covered with oilcloth, with benches to sit on. At one end is the kitchen, with an enormous stove and a great number of huge pots and pans, kettles and skillets. On the tables or the shelves is a great array of tin plates and cups, steel knives and forks, and pewter

Photos by Govt. of New Zealand, and American Lumberman

Some of the world's biggest trees grow in New Zealand. It is there that the kauri pine above is being felled. It may well be a hundred feet high. The snowy logging road below is in our own United States, where horses now do the work of the ox team shown in the inset, the stand-by of lumbermen in days gone by.

In the old-time logging camp the refrigerator was as large as all outdoors. Here the deer which is going to furnish the lumber jacks with fresh meat has been hung up outside the camp to freeze. Then it will keep indefinitely.

These are the bunks on which the lumber jacks sleep to-day. Mattresses have replaced the springy balsam boughs, and plaster on the walls helps to keep out the wind. But the "deacon seat" is still the chief article of furniture.

In this dining room there is sturdy work with knife and fork, for men who have been swinging an axe all day long in the cold, crisp air bring a healthy appetite to the table.

Photos by American Lumberman

spoons. There is nothing very fine in sight, but it looks as if they expected us to eat a lot.

Then there is an office building—goodness knows why they call it the "wanigan"!—with a stock of clothing, tobacco, and other things the men may need from time to time. And finally there is a blacksmith's shop and two stables for the horses and oxen. Out here in the wilds we call the stables "hovels."

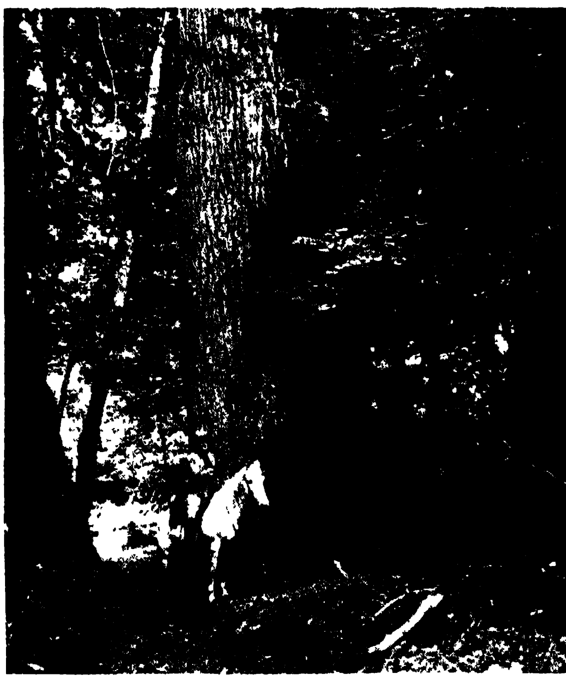
And then there is the logging road. This is a great path, eighteen or twenty feet wide, cut through the forest to a lake that drains into a branch of the St. Croix River. It has been laid out with the greatest care, and kept just as level as possible. For that reason it goes right through the swamps whenever possible, for a swamp is always level, and we shall not mind hauling the logs over the swamps, since they will all be frozen hard before we get to work. In fact as soon as the weather gets cold enough we are going to flood the path, and then we shall have an ice road all winter long for our trains to haul the great logs over.

With the first cold days the logging

Photos by American Lumberman

Down the slide the logs come crashing, and speed out into the stream that will carry them down to the mill. Or it may be that this whole forest out on the coast of Oregon will be floated downstream and made into rafts as big as an ocean liner and much the same shape. Then they will be towed some two thousand miles down the coast to be cut up into lumber. In the inset logs are entering the stream by a sluice.

crew begins to arrive. They have come on foot from Stillwater, the busy sawmill town down on the St. Croix, and have carried their "turkey," or traveling bag, all the way. It has been a four or five-day trip, with the nights spent at convenient stations where pioneer settlers along the route have given the men something to eat and a place to sleep. The men are husky customers, and anything but beautiful to look at. But that is only because they are dressed in the coarse clothes they need and because they have not seen a razor recently. They are really clean and kindly fellows, and we are soon going to find them full of fun and merriment. They need to be good-natured with the winter they are going to have ahead of them.



By National Park Service, photo by George A. Grant

In Olympic National Park, in the state of Washington, stands the "Colonel Graves" tree, a perfect specimen of Douglas fir. It is over twelve feet in diameter.

And now it is time for the first supper of the season. The men sit down on the long benches all around the tables, which are loaded with meat and beans, hot biscuits, stewed prunes, tea, pudding, cookies, and sirup. There are no potatoes—they would be frozen long before they reached us. There is no milk, no butter,—in fact, there are many things we must give up in the wilds. Of course there is no fresh fruit, and even canned goods are unknown; this is 1870, and their day has not yet come.

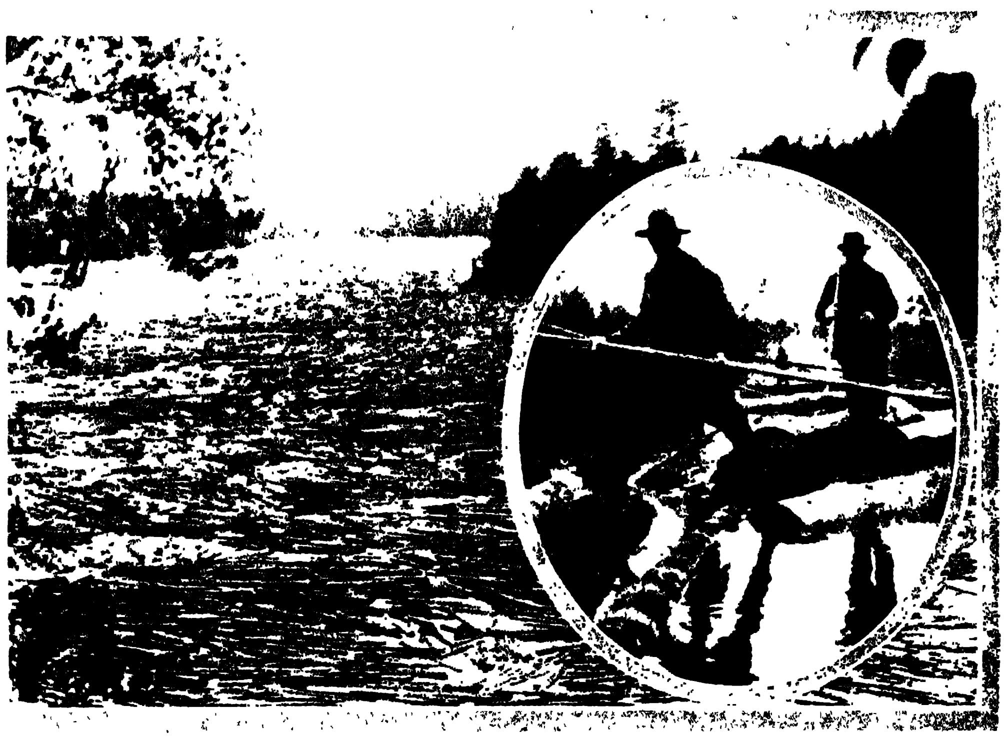
How a Lumber Jack Begins the Day

The cook is a big, merry Frenchman whom everybody likes. He and his "cookee," or boy helper, are two of the busiest people around. They have to have breakfast ready for the teamsters, who get up at four in the morning to feed the horses and oxen, and they are often working long after supper to get ready for next morning's breakfast. And what breakfasts these people will eat!

The blacksmith is another busy man, as we shall find. He must often work far into the night repairing broken tools that must be ready in the morning, and putting shoes on the animals. For when horses are going to haul heavy loads over an ice road they need the best of shoes to keep from slipping.

After a night of sleep in the wanigan, where the foreman and the chief clerk live, we open our eyes to broad daylight. In spite of our hard and springless bed, we have slept so soundly that we did not hear all the crew getting off into the woods hours ago. So we hurry through our "slapjacks" for breakfast, and make off after the men as fast as we can.

Then we see a sight. We never knew what a sharp axe could do before. These men are as clever with an axe as the most expert golfer with his clubs. They never seem to swing hard, but their steel bites very deep into the wood. They never make a useless motion, but they land their axe where they want it. They can make it shave down a big tree almost as cleanly as a saw, and they will have every tree falling exactly where they want it. If you dare them, they will drive a stake in the ground fifty feet away from the tree, and then bring down the trunk straight on top of the stake, to bury it



s by A ican Lumberman

Here a magnificent forest, hundreds of thousands of trees, is floating down to the mill. It will take quick work on the part of the rivermen in the inset to pilot those logs past all the turns in the stream.

in the earth. Once the tree is down, its branches are all off in next to no time, and it is cut up into proper lengths, ready to be hauled out when the moment comes.

So the men work on, with axe and saw, leaving the forest prone behind them. Then come the "swampers," to clear away all underbrush, and after them the "skidders," to drag the logs to the skidway by the side of the logging road. There the logs are loaded upon sleds and hauled off.

Where Oxen Are Better than Horses

The skidder drives a yoke of oxen—slower and steadier than horses, and less excitable. They are hitched to a short, three-cornered sled made out of the crotch of a tree and called a "scoot" or a "go devil." One end of the log is hoisted and fastened with a chain on the scoot, and then the oxen drag it off to the skidway.

The sleds on the logging road are big things from twelve to sixteen feet wide. They hold a great load of logs, lying side by side and one above another. The size of the load depends largely on the condition of the road, but over a level ice road a tremendous weight can be drawn by the strong horses. The largest load on record was shown at the Chicago World's Fair in 1893. It had come from a camp in Northern Minnesota, where four horses had hauled it. There were 63 logs in the load, containing 31,480 feet of lumber and weighing 114 tons—or more than three railway carloads.

All this keeps on right through the winter. Down comes the forest, off go the logs; by next year they will have turned into houses and furniture. But a great deal happens to them in between, and that is the best part of the story.

How Logs Come to a Sawmill

When the snow and ice melt, most of the men go back "down river" to their homes. But some of the skillful ones stay on. They will have their work in the great "drive" that is going to begin as soon as all the ice

Photos by American Lumberman

In this day of easy travel the lumber camp goes to the woods on wheels, and carries most of the comforts of civilization. Out of that kitchen in the inset the cooks send meals just like the ones at home.

has gone out of the lakes and rivers. That is the most exciting thing in the whole story.

For now we have our thousands and thousands of logs up in the wilds, and we must get them down to the sawmills far away. There is no way to haul them. There is just one path for them to travel. They must float down the river.

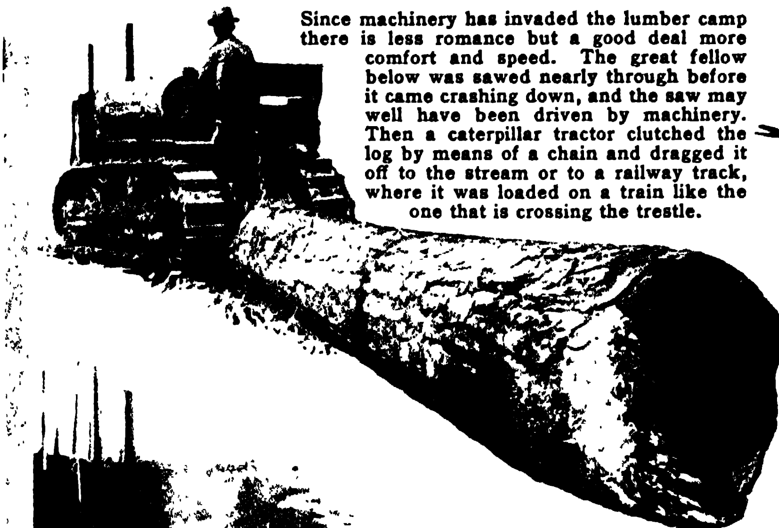
The Most Dangerous Job in the World

But if you throw a log into the river, do you think it will float quietly down to Stillwater? About one time in a thousand. The other times it will just drift in to the bank and stay there. And if you throw in ten thousand logs, it will be very much worse. They will float lazily down a little way until they strike some bad place in the river—a narrow neck, a sharp bend, a big eddy, or a set of rocky rapids. Then one of them will stop, and another behind it, and many more behind that; and before we know it, thousands of logs will get into a jam, piling up on one another in amazing shapes and blocking the whole river. Unless something is done quickly, the whole winter's crop of logs will pile up in one great jam—the most terrible thing a lumberman can face. How can he untangle it? And who will be brave enough to go out in the river and let loose all the power that is tied up in that river and straining to break free?

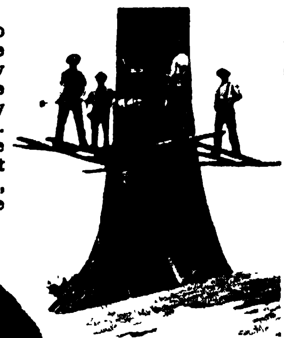
No, to get the logs down the river, we must have men on top of them to guide them down and to keep the thousands of them out of jams—no matter what rocks and rapids they may meet. These must be about the most skillful men in the world. There are only a few of them for the thousands of logs in the icy water. They must watch the whole caravan of trunks with an eagle eye, must spot any threat of a jam the instant it appears, and must dart from log to log across the swirling river to any point where they see trouble coming.

Riding Logs to Market

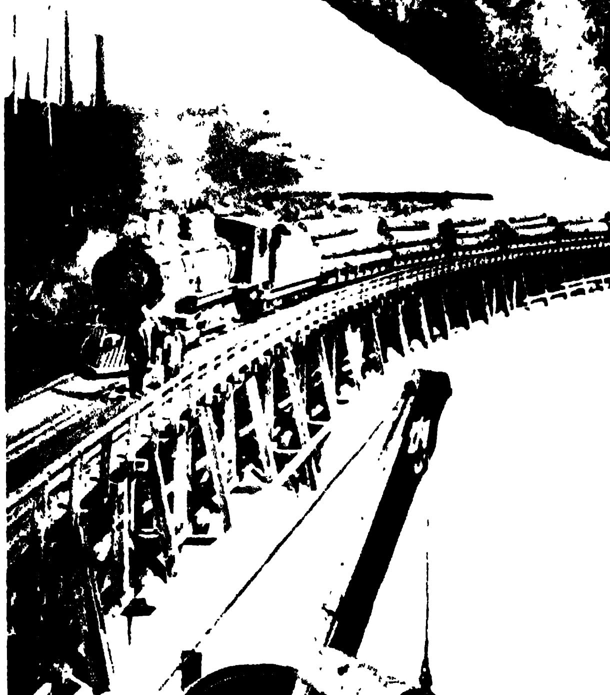
Now if you ever try to stand up on a log in perfectly still water—we say nothing of rapids and whirlpools—you will know a

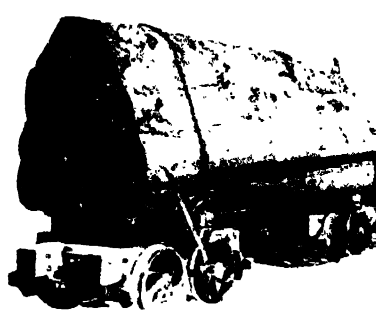


Since machinery has invaded the lumber camp there is less romance but a good deal more comfort and speed. The great fellow below was sawed nearly through before it came crashing down, and the saw may well have been driven by machinery. Then a caterpillar tractor clutched the log by means of a chain and dragged it off to the stream or to a railway track, where it was loaded on a train like the one that is crossing the trestle.

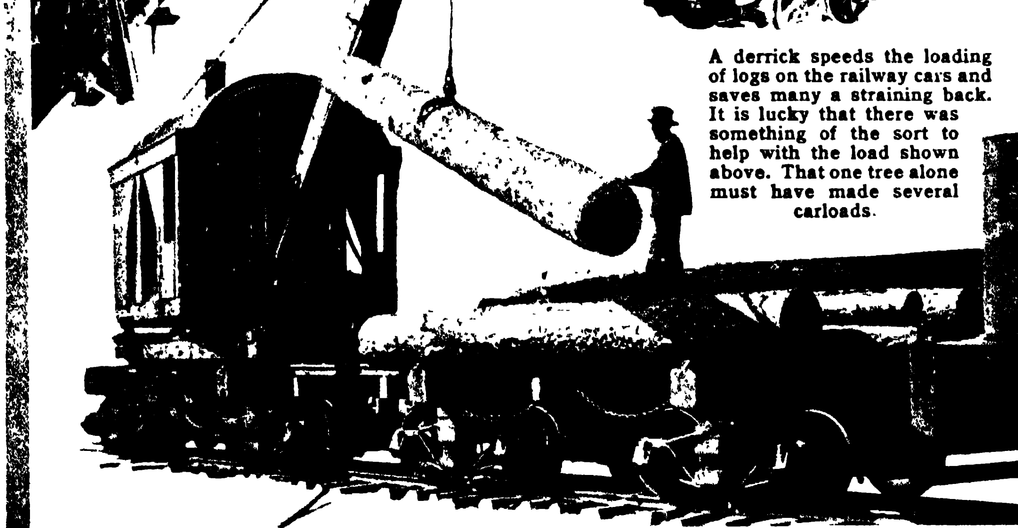


There still is need for the axe when the lumbermen meet a problem like the one above.

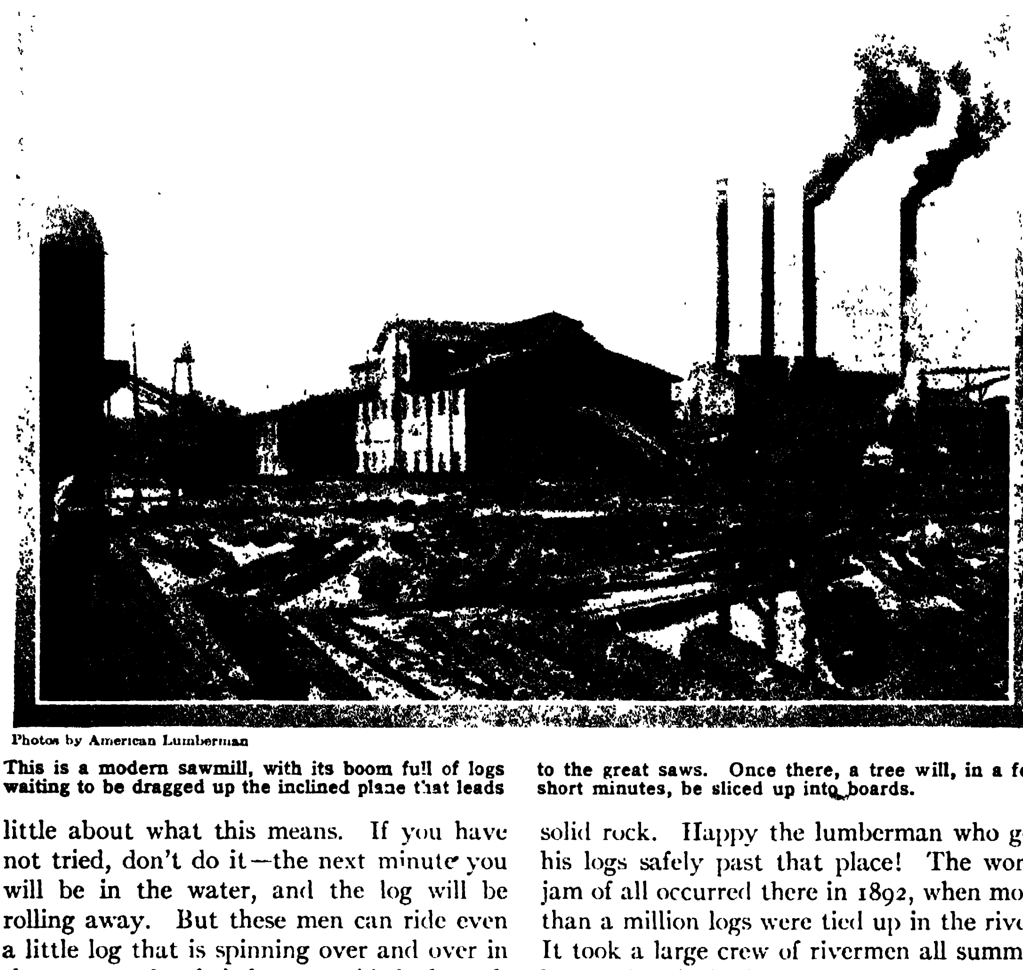




A derrick speeds the loading of logs on the railway cars and saves many a straining back. It is lucky that there was something of the sort to help with the load shown above. That one tree alone must have made several carloads.



Photos by Govt of New Zealand, American Lumberman, and Caterpillar Tractor Co



Photos by American Lumberman

This is a modern sawmill, with its boom full of logs waiting to be dragged up the inclined plane that leads to the great saws. Once there, a tree will, in a few short minutes, be sliced up into boards.

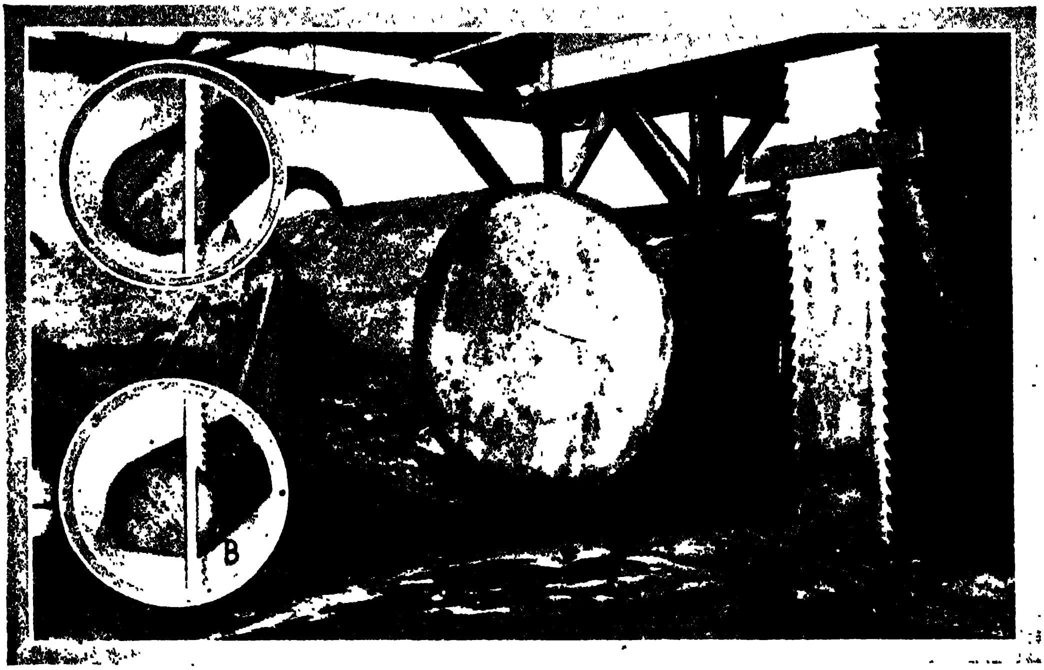
little about what this means. If you have not tried, don't do it—the next minute you will be in the water, and the log will be rolling away. But these men can ride even a little log that is spinning over and over in the water under their feet, can ride it through the rocks and rapids. They can leap from log to log like a squirrel in the branches of a tree, and they will hardly ever get a wetting. They must do it in the dark as well as in the daylight, for the river does not stop at night. And but for this marvel of skill, the logs would never get down the river. If these men did not start every log going again the moment it got tied up, the whole river would be one vast jam.

A Jam of a Million Logs

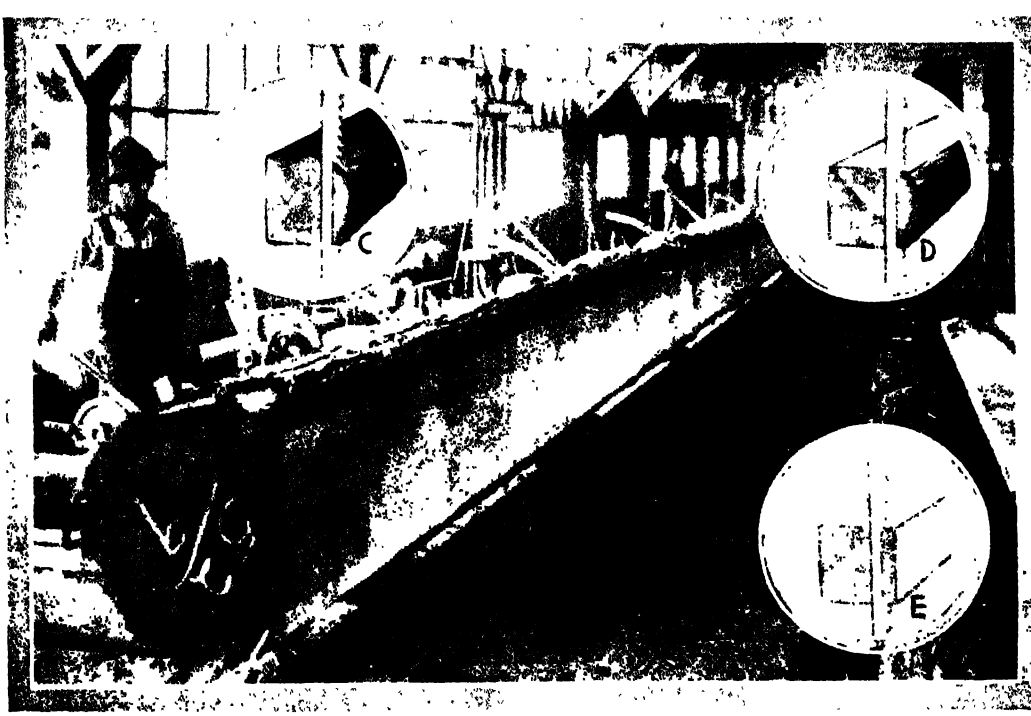
In spite of all their skill, there used to be a big jam once in a while. There was a very bad place in the river at Taylors Falls, where the St. Croix suddenly narrows and makes a sharp turn between high banks of solid rock. Happy the lumberman who got his logs safely past that place! The worst jam of all occurred there in 1892, when more than a million logs were tied up in the river. It took a large crew of rivermen all summer long to break the jam.

The End of the Good Old Days

Now a good deal of what we have been saying belongs to a past that is dead and gone. We have been talking of the golden days of lumbering, when the first men went out to cut down the virgin forests. The axe has gone since their day, and the saw has come instead. Oxen are gone, and the tractor has replaced the six-horse teams with their gay tassels and their jingling bells. Great tramways have been built for hauling lumber, summer and winter. Jams are very rare now, because we have built great dams to regulate the flow of the river and the number of logs in it. The whole business is done better—but it is far less romantic.



The pictures on this page show you how a huge log, like the one above, is sliced up into boards. First a piece is taken off each side, as shown at A, B, C, and D. This "squares" the log and removes the bark.



After the log has been squared, the band saw slices off one board at a time, as shown at E. The thickness of a board is regulated by the lever in the hand of the man above. If the board is to be one inch thick, he pushes the log forward with the lever until it lies just one inch beyond the line of the saw.

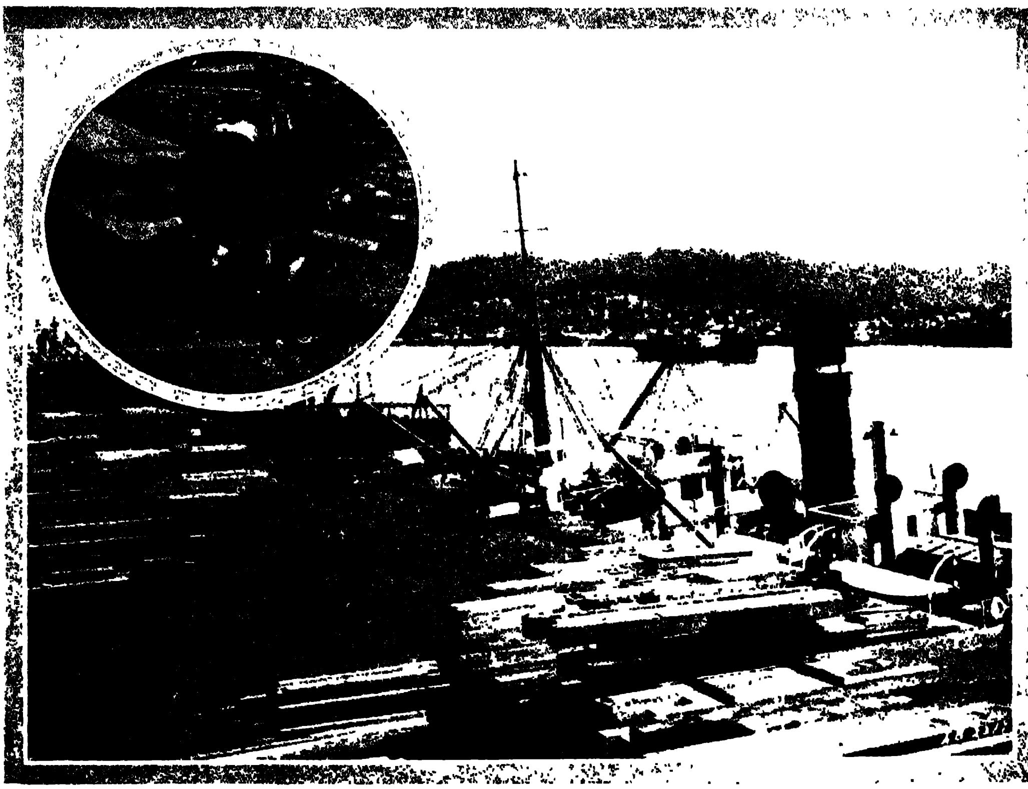


Photo by American Lumberman

From this dock on the west coast of the United States hundreds of thousands of feet of lumber are shipped every year to the East by way of the Panama Canal. The inset shows a patient four-footed dock hand.

Yet there is still room for the skillful rivermen, and their work is often very much the same as of old. The logs coming down a river may belong to various companies that have big sawmills at different points on the way. Each log has a special mark cut into it to show what company it belongs to, and what sawmill it must reach. The rivermen must sort out all the logs as they drive down the stream, and float them into the right places. Every mill has a big enclosure called a boom—a floating fence in the river fastened from end to end with stout chains—and the rivermen must herd all the logs into the boom where they belong.

Turning a Log into Lumber

From the boom the logs go to the mill where they are sawed up into lumber. Many of us have seen this done, at least on a small scale. The big logs are lifted on a trucklike carriage that runs back and forth on a steel track. Each time the carriage brings the log forward, a whirling saw rips off a slice as thick as the sawyer may desire, and in a little while the whole logs have turned into planks. The head sawyer need only know what kind of planks are wanted, or what kind each log can best make; then he can set his machine accordingly, and turn them out.

Buzzing Saws of a Busy Mill

The sawmill is a very busy place, and a very noisy one. It does many kinds of work, and needs many kinds of saws to do it. There is the large circular saw that eats right through a log in the way we were just describing. There are also band saws, or endless belts of steel with saw teeth, that pass around two pulleys, one above the carriage and the other below it. These are best for sawing very large logs, such as those of the huge fir and redwood trees on the western coast.

These saws work very fast, but cut off only one slice at a time. Gang saws go more slowly, and work up and down like a hand saw; but they work in gangs, and will saw off from two dozen to five dozen slices, according to the size of the logs, at one time. They may saw two or more logs at once, on top of one another.

Of course there are special saws for special things, as for cutting laths and shingles. And finally there are planing mills, where the rough planks that come from the saws are "dressed" until they are as smooth as the top of a table.

How We Keep Boards from Warping

All wood must be dry before it is made into finished planks, for otherwise it will warp and get out of shape. Sometimes it is simply stored in sheds until it dries out, but most of it is now dried in heated kilns. Yet this must be done with care. For wood shrinks as it dries, and if the outside is allowed to dry faster than the inside, it will crack open. For that reason the heat and the moisture have to be carefully regulated in the kiln.

At one time the forests of the United States covered 822,000,000 acres of land. Now there is only a small fraction of it left. We cut up many billions of board feet of lumber every year. The states of Oregon and Washington stand first in the industry, but California, Alabama, Mississippi, and the southeastern states all rank high. In the days when there was plenty of timber, we simply cut where we liked, and left the waste behind us to grow up again as best it could. Now we have to be careful to plant new forests wherever we cut them down.

In the amount of standing forest Russia now leads the world. The United States and Canada still have plenty of timber. In the older countries of Western Europe the great forests are planted by hand, and in their magnificence they show what man can do to replace the trees he has destroyed.

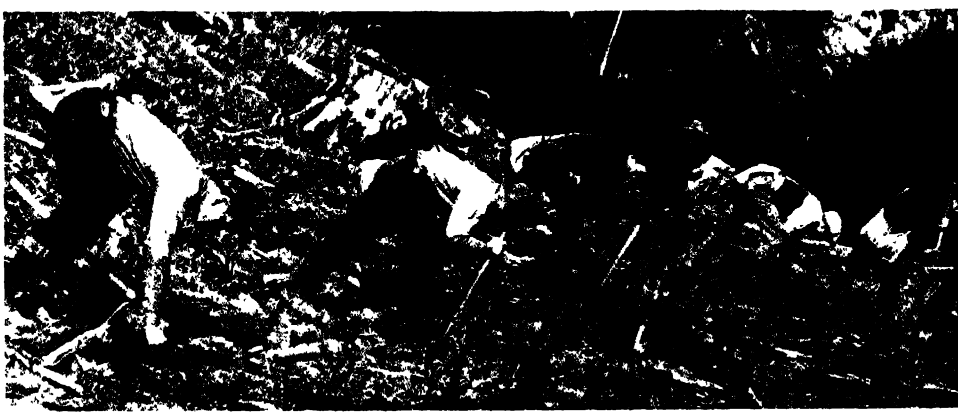


Photo by Calif.

Long before the dawn of history the hardy race that lived in Norway and Sweden had learned that if you cut down a forest you must put it back again. It is only lately that we have realized this in the United States. But now Uncle Sam is trying his best to preserve his forests, which are so great a source of wealth. Above, you will see a crew of men at work setting out trees on land where timber has been cut down.

The many kinds of lumber are often divided into "soft woods" and "hard woods," though the division is by no means a good one. It does not mean, for instance, that a given wood is really hard or soft because of the name we give it. To most people in the lumber business the soft woods are those that come from trees that bear cones and needles, while the hard ones come from trees with broad leaves.

The Uses of Hard and Soft Woods

Thus the common soft woods are pine, fir, spruce, hemlock, cedar, larch, and tam-

arack, while the best-known hard woods are oak, maple, ash, birch, elm, hickory, poplar, and walnut.

But there are many varieties of every one of these, and each variety has its own peculiar ways—and therefore its own peculiar faults and virtues for our purposes. The varieties are often known by different names in different places. The oaks, for instance, are very numerous and very different; among the many kinds are the white oak, black oak, red oak, blue oak, yellow oak, swamp oak, post oak, scrub oak, bur oak, pin oak, and still others.

The Trees That Give Us Lumber

Pine is the commonest lumber for general purposes, and white pine is the best. It is soft and easily worked, but it has a fine grain and is strong and lasting. White pine is rather scarce in our day, and in many places is not found at all. The red and yellow pines are harder, coarser, and more brittle, though a good deal of yellow pine is now used, especially in the southeastern states.

Douglas fir has now come into a good deal of favor, especially as new uses and new ways of treating it have been found. Spruce and hemlock are used mainly for rough work, in the form of heavy lumber. Red cedar is made into chests and panels, and very largely into lead pencils—some tens of thousands of the trees are cut down every year for pencils alone. White cedar, or arbor vitae, goes into telegraph poles, fence posts, and shingles. Tamarack will not make good boards because it is so rarely straight in grain, but it is put into the frames of buildings and into posts and fences.

The most popular hard wood is oak. It is hard and strong, has a fine grain, and takes a high polish. We put it into floors and finishings, into furniture and many other things. Hickory and ash are very strong and hard, and go into tool handles and all kinds of vehicles. Maple, birch, and walnut are all used for furniture and for interior finishing. Of these walnut is the most popular and the most costly. Elm, poplar, and basswood are used largely for boxes and crates.

We get a good deal of lumber from other lands, but mostly of a special quality and for very special uses. The most important woods that we import are ebony, mahogany, rosewood, Spanish cedar, and teak.

Ebony is the heartwood of a tree that grows in some of the hot countries; the best comes from India and Ceylon. It is jet-black, and very hard and heavy. We use it for our black piano keys, for knife handles, cane heads, and for carved ornaments of many kinds.

Mahogany is one of the costliest and most beautiful of woods. There is very little of it left in the world, for it has mostly been used up, and the rest is pretty carefully protected. What remains now is found in Honduras and other Central American states, in Mexico and the West Indies. A large tree may be a hundred feet high and ten feet thick at the base; and such a tree is worth a fortune. The beautiful reddish brown wood is very hard and fine of grain, and is made into fine furniture and fixtures, and into musical instruments But most of our "mahogany" now comes from other kinds of trees

Rosewood is so named for its fragrance, and comes from several kinds of trees in Brazil. It reaches us in large slabs and is then cut into very thin sheets which are used as veneer--which means that they are glued over other cheaper woods to give a fine finish. This wood is used in furniture and in scientific and musical instruments.

Spanish cedar comes from Mexico, Cuba, and the West Indies. We import many millions of feet of it every year, and use it mainly for cigar boxes.

Teak is one of the most costly kinds of wood in the world. It comes from India, Siam, Burma, and the Malay Peninsula. It is easily worked and takes a very high polish; and when it is seasoned, it will not shrink or crack or split. Teak is the one wood that the termites, or white ants, will not ruin, for it contains an oil that they do not like. It is the most lasting wood we know, and is used for fine furniture and fixtures—though it is so expensive that we do not see much of it.

Reading Unit
No. 2

THE JUICE THAT MAKES TIRES FOR YOUR CAR

Note: For basic information not found on this page, consult the general Index, Vol. 15.

For statistical and current facts, consult the Richards Year Book Index.

Interesting Facts Explained

When did Europeans first see rubber? 9–261
How elastic is rubber? 9–262
Friction and rubber, 9–262-63
What is rubber? 9–263-64
Tapping rubber trees, 9–264-65
Wild rubber, 9–264
Rubber plantations, 9–264-67
Treating rubber, 9–268-71
Artificial rubber, 9–271-271B

Things to Think About

What every-day products would we miss if there were no rubber?
How has the shortage of rubber been overcome?
What difficulties did the early rubber manufacturers encounter?
How could rubber, as we know it to-day, be improved upon?

Related Material

Why is hard rubber often used for pot handles? 1–396
How is rubber used in electrical devices? 1–514
What material is used for making the gas bags of airships? 10–314, 319
How are rubber balloons used to study the atmosphere? 1–218, 259, 278
How is a golf ball made? 14–495, 9–309
How are shoes made? 9–54-64
How is compressed air used in automobile tires? 1–460-62
How does sulphur make rubber usable? 1–547, 9–268

Practical Applications

How is old rubber used to maintain our rubber supply? 9–271
What did Goodyear do to make rubber useful? 9–268-70

Leisure-time Activities

PROJECT NO. 1: Get some latex from a large rubber company and vulcanize some of it with sulphur in boiling water, 9–268.

PROJECT NO. 2: Find out how many different plants can serve as a source of rubber, 9–261-62.

Summary Statement

Rubber, which we get for the most part from certain plants, provides man with more than 30,000 useful articles.

Here is shown just one of the pieces of wizardry that take place by the thousand every day in our modern factories. At the top rubber is coming in thin sheets from the calendering machine. Before it entered the machine it had been mixed with sulphur and softened by heat, so that the heavy rollers of the calender could iron it smooth. The next process will be to expose it for some half hour to a very high temperature that it may be vulcanized. The sheets of rubber are then ready to be made into the tires shown at the bottom of the page. The inner tubes can be made all in one piece, like a pipe, by forcing the heated rubber through a die

Below is the machine that stamps the pattern of the tread in the covering of the tire. At the bottom of the page tubes are being inserted in tires.

Photos by U. S. Rubber Co.

to by National Museum

The simple savages who fell down and worshiped Columbus and his crew knew a number of things that they could teach the white men. Here they are shown playing with balls of the miraculous stuff we call rubber.

The JUICE THAT MAKES TIRES *for* YOUR CAR

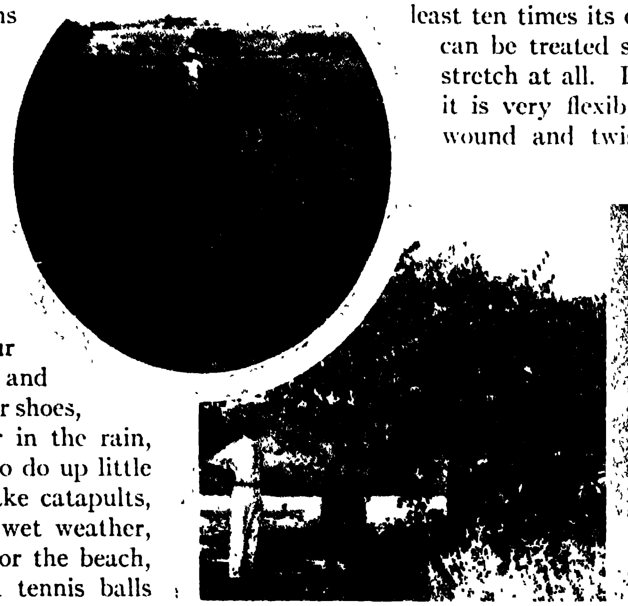
All Rubber Drips Out of Trees into Little Cups; and This Will Tell What We Have to Do to It before We Can Use It

ON HIS second trip to this side of the ocean, Columbus saw some Indians playing a game with a black ball that bounced as he had never seen anything bounce in the world before. He took several of the balls back to Spain with him and showed them around as great curiosities. They seemed to bounce about like grasshoppers.

Columbus had very little notion what the stuff in the balls was, and never did he dream how important it was going to be for us long after he was dead. He did not even know what to call it. The Indians had called it something like "koo choo," and the Europeans got about as near as they could to that by calling it "caoutchouc" (kä′ōōt′-shōō′); and this has remained its name in nearly every language except English. But centuries later an English scientist named Joseph Priestley was using it as the best stuff to rub out pencil marks that he wanted to erase; and since he was always rubbing out the marks with it, he simply called it "rubber." And that is what we call it to this day.

It was a most remarkable thing to find. For rubber is one of the most peculiar substances in the world. It is the most elastic thing we know, in the first place, and that is what made it astonish its discoverers by its bouncing. It is also waterproof; and not so very long after its discovery the king of Portugal sent several pairs of his boots over to Brazil to be coated with rubber in the way that the natives there coated their own. Through the various ways that we have found of treating it, and of combining

it with other substances, rubber can be made into about as many thousands of very different things as any product in the world —so many thousands, and such different things, that if old Columbus could ever have dreamed of them he would have rubbed his eyes in a way that no dancing ball would ever have made him rub them. For rubber has now come to be one of the very foundations of the lives we lead, and a great part of our civilized world would go to pieces without it.



Photos by U. S. Dept of Agriculture

In the oval above is shown a field of desert milkweed at an experimental station in California. This species of milkweed can be made to yield rubber. It grows much like grass, and could be harvested in the same way. The rubber vine, too, contains a juice that can be made into rubber. In the square is shown one of these plants growing in Florida.

Out of the many forms of rubber, we make the erasers in our pencils, the soles and heels of many of our shoes, the coats we wear in the rain, the elastic bands to do up little packages or to make catapults, the overshoes for wet weather, the bathing caps for the beach, the golf balls and tennis balls and footballs for our games. We make stoppers for bottles, sponges and mats for the bathroom, gloves and aprons for surgeons and housewives, rings for jars of preserves. We make fountain pens and combs and pipestems and telephone receivers. We make hose for the garden and enormous belts for machinery, linings to insulate the electric wires in our homes or the great electric cables under the sea. We make gas masks and shock absorbers and balloons, big and little. We make linings for pipes and tanks that carry chemicals which would ruin almost any other substance. Above all, perhaps, we make tires, and so we speed all over the world on rubber with air inside it. And these are only a few of the thousands of things we make out of rubber.

Think a moment of how much we should miss if we had no rubber. Think a moment of a thing that can be made into a glove or a sponge, a comb or a tennis ball, a boot or a balloon or a telephone or an Atlantic cable. You will soon realize what an extraordinary thing rubber is. And it is extraordinary because in its different forms it combines so many different properties, sometimes even opposite properties.

First of all, it is very elastic—in the most elastic form it will stretch to at least ten times its own length; but it can be treated so that it will not stretch at all. For another thing, it is very flexible, and so can be wound and twisted around anything—though it can also be treated till it cannot be bent at all. Then, too, it will not let through any air or water, and very little heat or electricity—though it can be treated to make it into a sponge, or even into an electric conductor. It has great resistance to wear and tear, as we see from the rubber heels that we pound on the pavement so many times, and so it is used in beltings and conveyers where the wear and tear are very great; and yet it can be made into a form where it wears away like the erasers in our pencils.

Rubber Obeys Our Command

It does not suffer from the action of water or of many of the very strong chemicals, and that is why we line so many tanks and pipes with it. When it is dry, it has a very high friction—that is, it will not slip over a surface unless pushed very hard, as you have noted if you have ever tried to dance

Photo by U. S. Rubber Co.

When a rubber plantation is started, the first step is to clear the dense tropical jungle where the trees are to grow. It is a tremendous undertaking. The picture above shows a clearing opened in Java.

in rubber soles. That is a reason why it is useful for belts, for it will not slip on the wheels of the machines. But when it is wet it slips very easily, as you have also noted from your rubber heels in icy weather; and that is why it is used in such places as propeller shafts, where the least friction is desired for something that is turning very rapidly.

Thirty Thousand Uses

These and other properties make it the remarkable thing it is, and give it all the varied uses it has for us—no less than some thirty thousand of them in all.

But it was a long time before we found out all these uses. The rubber that Columbus knew could never have done these things for us. Many a year of discovery had to pass before we knew how to do all the things we now do with it. And now we are going to tell how many of these things were found out. To do that we must first go far back to see what our rubber is like when it first comes to us—out of trees in the forest.

Rubber comes from a juice that grows in many kinds of trees and vines and other plants, in many parts of the world. There are over a thousand kinds of plants that produce it, perhaps over ten thousand that will yield it in very small quantities. We have found out that if all the other supplies of rubber should fail, we could get large quantities of it out of our goldenrod. But although we can get rubber out of various kinds of trees and vines, and actually have taken it from several of them, the great supply comes from the hevea (hē′vē-ȧ) trees—*hevea brasiliensis*—which are native to tropical South America, and especially to the valley of the Amazon in Brazil.

Aside from these trees there are a few other plants that still give us a little rubber, sometimes very good and sometimes pretty poor. There is the India-rubber plant in India—a kind of fig tree. There is another tree and several kinds of vine in Africa, and among other things, a bush called "guayule" in Mexico and the Southwestern United States. Guayule (gwä-yo͞o′lĕ) was widely planted during World War II. From all these we can get a little rubber, and during World War II we experimented with all of them when ordinary rubber was cut off. But none of them can equal the hevea tree, and from now on we shall speak only of that.

The fluid in this tree that gives us rubber is not the sap. It is called "latex" (lā′tĕks), which simply means "fluid," and it is found

in the tiny sacs of the inner bark of the tree. It seems to have been meant by nature simply to flow out when the tree was wounded and to protect the tree by hardening in the wound.

To get the latex out of the tree we have to cut a wound in the bark. This must be done very skillfully in order to go deep enough to get all the fluid we can and yet not hurt the tree—for we want to tap it many times again. There are several kinds of cut we can make, as you will see in the pictures. One is a spiral, winding round the tree as it goes upward. Another is a herringbone cut, with one groove up and down the trunk and smaller, slanting grooves running out and upward from it. Whatever the cut, it must go very, very close to the inner surface of the of the bark without ever piercing quite through; and whatever the cut, it must have a little cup at the bottom into which the latex will flow.

Left: Planting the precious seed that is going to produce many automobile tires. Rubber trees must have a high, even temperature and very moist soil, and they do not like high winds.

Photos by U. S. Rubber Co.

Owners of rubber plantations have learned how to graft a bud from a tree with a high yield of rubber into the bark of a young sapling. In time the bud grows up to be the main body of the tree, with all the rubber-yielding powers of the mother tree and the vigor of the sapling that furnishes the root.

In the jungles of Brazil it used to be terrible work to get the latex out of the trees and bring the rubber into camp, and indeed it is often very hard work to this day. The natives had to go out at daybreak through swamps of mud and water, and through underbrush where they often had to hack their way to the trees that bore the precious fluid. From one tree to another they would travel on their lonely way. Then they would collect the cups and bring in the fluid. At once they would set about getting the rubber out of the latex, for like all other vegetable products the latex would spoil if they waited too long. In a moment we are going to tell how they got the rubber out. Then they would start off for another round of their trees.

Those days are not over, for though the conditions are better, there are still many workers threading the jungles of Brazil and tapping the wild rubber trees. But a good while ago we began to set out great plantations of rubber trees in various other parts of the world, and now a great deal of our rubber comes from orchards of these trees. In these we can tap the fluid as easily as we can pick apples in another kind of orchard.

For a long while a country like Brazil would do all it could to keep any seed of the rubber tree from getting out of its own land. The product was too valuable to let any other land grow the trees if that could possibly be helped. The hevea tree was guarded just as the silkworm used to be guarded many centuries ago in China. But of course it could not be kept forever. About a century ago an Englishman was saying it might be a good plan to try to grow hevea trees in certain parts of the British empire, and so bring down the price of rubber. But it was not till about 1875 that, after some unsuccessful attempts, another Englishman managed to get a large quantity of the seed out of Brazil. At once it started to grow up into trees in the hothouses at Kew Gardens, near London. The little trees

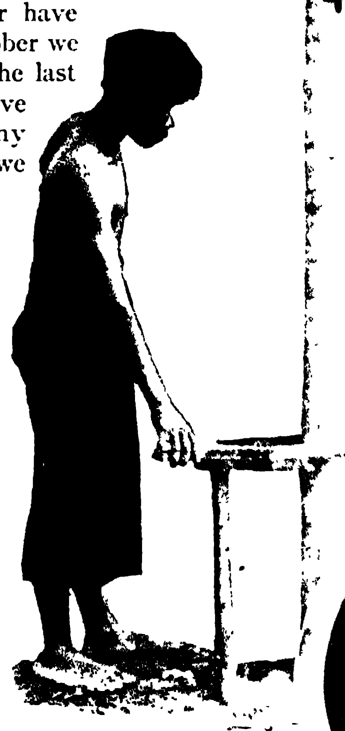
Photos by U. S. Dept. of Agriculture, and Visual Education Service

Natives in Mexico tap the rubber trees after the manner shown in the large picture. But the tree is often injured. On large plantations in Java small knives are used, and the bark is cut as shown in the inset.

were sent posthaste to be planted in warm Ceylon, where they throve; and that was the beginning of the vast groves of rubber trees that now grow in the East—in Ceylon, Malaya, Sumatra, Java, and other lands in that part of the world.

So a very large part of our supply of rubber now comes from cultivated trees—and the number of these has grown by great bounds since the coming of the motor car and the demand for rubber tires. The wild forests could never have given us all the rubber we now need, for in the last thirty years we have come to use many times the quantity we needed before.

The trees that give us rubber are pretty big ones. They may grow as high as 75 or even 100 feet, and may be 10 or 12 feet around. They begin to give us latex when they are five or six years old, though at first of an inferior quality; only when they are older do we get the best rubber from them. A full-grown tree will give us about half a dozen pounds of rubber a year, though some may yield a great deal more. Of course when we have cut away its bark in tapping we have to let it rest for a time; but in a few years it will grow a new bark, and we can tap it again—and so on throughout the life of the tree.



Photos by U. S. Rubber Co.

A native worker has no trouble deciding when a rubber tree is old enough to be tapped. He just slips a gauge over the tree, and if it fails to pass around the trunk, he knows that the tree is large enough to yield rubber.

In the oval is one of the native belles who work on the rubber plantations in Java.

On the plantations we get out the latex in about the same ways as did the Brazilian pioneers of old, though much more safely and easily—and also much more scientifically, for we have called in a great deal of aid from science to help us grow fine trees and get great crops of rubber. But we still tap the trees in about the same old ways to fill our little cups with the precious latex.

Now latex is not rubber—it is more like milk—but it has tiny particles of rubber floating in it, far too small for the naked eye to see. The first thing to do is to get these out. Then the raw rubber resulting must be sent off to the mills, where it will go through a long series of varied processes to turn it into all the kinds of things that we were mentioning in the beginning of our story. We are going to follow the latex through some of these processes, and once more we must look to the pictures to help us.

First we must get the rubber out of the latex—and pretty quickly, before the latex spoils. The old Brazilian had his own way of doing this, which is still used in the wilds. When he came in with his day's gathering of latex he built a fire under the pot containing it. Into the heated latex he then dipped a paddle over and over, to let the particles of rubber gather on it. When the end of the paddle was all covered with rubber, he tore the stuff off and ran a pole right through it. Then he put the pole itself over the fire on two forked sticks, with the ball of rubber in the middle; and over the ball he kept pouring little streams of the latex, very slowly. The rubber in the latex kept collecting on the ball, which grew bigger and bigger. When the ball was big enough, he took it off the pole. That was the end of his work. He then sent the ball of rubber off on its way to the factory—in some distant land.

Photo by U. S. Dept. of Agriculture

Here is a native rubber gatherer in the New World, together with his home, his wife, and his family. He is carrying his implements, and on his back is the wicker basket which holds a rubber bag for the latex.

There have been and still are some even more picturesque ways of getting rubber out of latex. In Africa, for instance, some of the naked natives smear the latex from their vines all over themselves and let it leave a coat of rubber on them as it dries. Then they peel off the rubber and roll it into a ball—for of course it is pretty sticky in this state—and send the ball off to civilization. In the Philippines the natives catch the juice from their vines in coconut shells and pour it into the salt water of the sea to harden it. And there are still other methods in other places.

Getting Rubber Out of Juice

On the plantations this is all very much easier. The latex is poured into big tanks and some kind of chemical is added, often acetic (ȧ-sē'tĭk) acid, which makes the rubber rise to the top, like the cream in milk. Then it is skimmed off, washed, dried, and ironed into sheets. When these sheets have been folded and pressed into the blocks called "biscuits," they are ready to go off to the factory. And there is still another method known as the "spray" process. The latex is sprayed out into a room so hot that the moisture in it all evaporates, and the particles of rubber fall to the floor.

The Trip to the Factory

Recently a way has even been found to ship the latex in tanks straight to the factory, just as oil can be shipped.

But the rubber that gets to the factory is still very different from any rubber that we ever see. It is nothing like an eraser or an elastic band, and still less like a golf ball or a tire. As yet it is not good for very much—because for one thing it will get hard and brittle when very cold, but will turn far too soft and smelly when it gets hot.

That is why it took so long after Columbus' time before we found out what we could do with our rubber. Until about a hundred years ago it was not of very much use to us.

To be sure, a certain sea captain trading with South America in 1823 had brought to Boston a few clumsy pairs of shoes made out of crude rubber, and had sold them for high prices. In the next fifteen years about a million pairs like these first ones were made and sold. About the same time Thomas Hancock worked out a way of preparing rubber by machinery and began to make such things as hose, belting, shoes, and inflated bags. And in 1823 a Scotchman named Charles Macintosh took out a patent for making raincoats of rubber. He dissolved rubber in coal-tar naphtha and spread it out in a thin sheet on a marble slab. Then he sewed the sheet of rubber between two fabrics into a coat. His coats did not prove good ones because the rubber melted in the hot sun or near a fire—but we still call a raincoat a "mackintosh."

The trouble was that we still had to find the way to make rubber stay the same—in heat or cold, and under exposure to all sorts of chemicals. And the way to do this was the discovery of Charles Goodyear, in 1839. What Goodyear did was to find out how to "vulcanize" rubber—by far the most important discovery in its history, and the one on which nearly all its present uses rest. So the name of Goodyear is easily the most famous one in the realm of rubber.

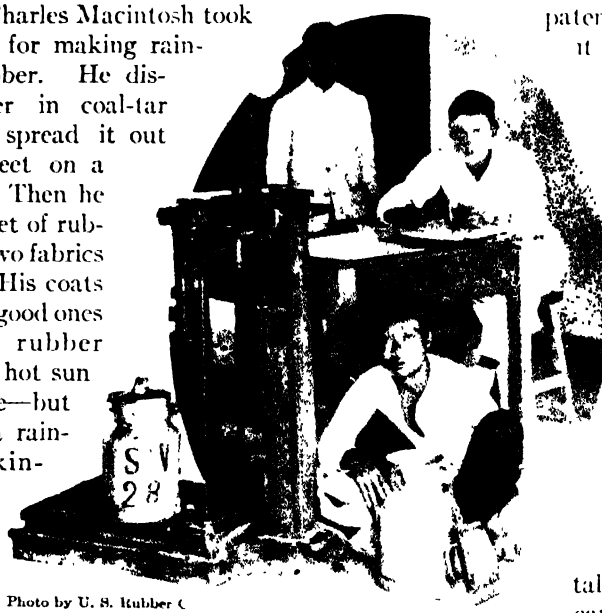


Photo by U. S. Rubber C

In the tropics the native rubber gatherer replaces the trapper of the north. Here his "catch" of latex is being weighed at the company's station.

The Man Who Made Rubber Useful

Charles Goodyear (1800–1860) was born of an inventing family in New Haven, Connecticut. He worked for ten years or more in the effort to make rubber stand heat and cold, and bought the imperfect process of Nathaniel Hayward of Massachusetts, who had been working on the problem before him. Hayward had tried mixing rubber with sulphur to make it do all sorts of work, but was far from succeeding. One day while Goodyear was experimenting with the two substances he accidentally dropped some of them on a hot stove—and the riddle was solved! When he took the mixture off the stove he found he had what he wanted—a rubber that would stand heat and cold and acids, that was elastic but not sticky. He patented his process and called it "vulcanizing," after the name of Vulcan, the old god who forged the thunderbolts for the deities of the Greeks.

And that is the chief thing we do to make rubber into all the things we want it to be. We mix it with sulphur, under heat. Mainly according to the amount of sulphur we put into it, we can turn it into the very different objects about which we were talking when we started; we can make it hard and brittle, or soft and elastic and flexible. Of course we do many other things to it also, and mix it with still other substances according to our need; but the main thing is the sulphur.

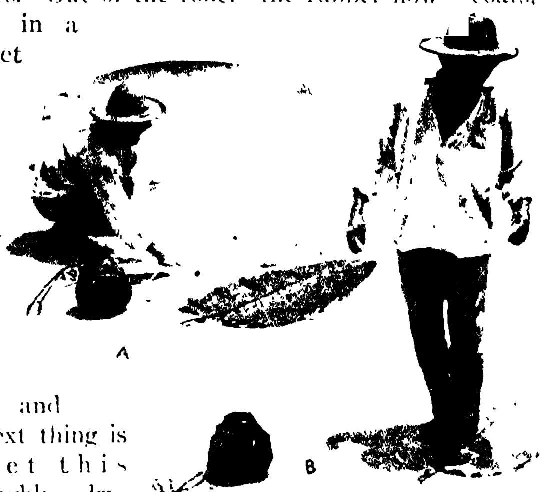
We have had to say all this about vulcanizing before we started to follow our crude rubber through the factory, because that is the main thing that happens in the factory to turn the crude stuff into the rubber we are always handling. Now let us go back once more to the crude rubber just coming to the factory and watch some of the things that occur to it as it goes through the mill.

It arrives in many forms, and is of various qualities, so it has to be examined carefully to see how pure it is and what it is best fitted for. Until we are ready to run it

through the mill we must store it safely in some cool, dark place, commonly a great cellar. When we are ready we take a mass of it out of storage and soften it with hot steam. Then we run it through great rollers under heavy pressure, with water spraying on it all the while. This washes out the impurities. Out of the rollers the rubber now comes in a soft, wet sheet and the next thing is to get this thoroughly dry. There are several ways of drying the big sheets.

When it is dry we must run it through other big machines which knead it into a doughy mass again. Then it is ready for the vulcanizing. In the next set of processes we therefore mix in the right amount of sulphur—just as much as will be needed for the kind of thing we are going to make of the rubber. In general, we put in very little sulphur if we want the rubber to be soft and flexible, but a great deal more if we want it to be hard and stiff. We put in many other things too. There are several hundred other substances that we can mix with rubber, in varying quantities, to give it just the character we desire—even to give it just the color we desire, gray or red or blue or yellow. Whatever the mixture, the whole mass is now run through some heavy rollers once more; and this time the sheet that comes out is the rubber that we all know. It is ready to be worked into the objects we are going to use.

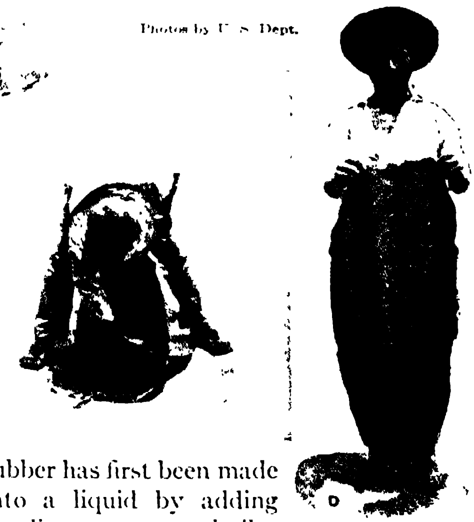
The ways in which we make those objects are about as varied as the ways in which we get the rubber ready for them. We can see that they must be extremely various, for such things as gloves and overshoes, raincoats, and tennis balls or tires. In the old days some of the Indians used to rubberize their shoes by just dipping them time after time into latex, and letting a little rubber dry on them between each dipping. To make our gloves and many other objects we still dip a mould, not into latex, but into rubber. The rubber has first been made into a liquid by adding gasoline or some similar thing; then we dip in the mould and take it out coated with a glove or a bathing cap or a toy balloon, as the case may be. Combs and pipestems and telephone receivers are also made in moulds.



In Mexico the native rubber gatherer spreads his latex over a huge leaf to dry, as is shown at A.

Two leaves that have been smeared with latex are laid together, like the slices of a sandwich, and are pressed down firmly by the simple and easy method shown at B.

Photos by U. S. Dept.



When the crude rubber has been transported in its simple leafy container, all the worker needs to do is to peel the leaves away from the thin sheet of rubber between them, as shown at C.

At D is the sheet of rubber that is peeled off the leaves. It bears the marks of all the ribs and veins.

A raincoat may be made by actually forcing the rubber into the spaces of the cloth fabric, or by coating the fabric with a sheet of rubber on the outside. We are very familiar with both kinds of coat. In hose and machine belts and overshoes we first squeeze rubber into the fabric on the inside, and then put a coating of rubber,

as thick as necessary, on the outside. If you will look at the inside and outside of your overshoes, or tear up an old pair, you can see how it is done.

And in general that is the way we make an automobile tire. But this process is so special that we ought to tell a little more about it—especially because such a vast part of our rubber now goes into tires. We start with sheets of very thin rubber and with thicker sheets of the strongest cotton or cord fabric we can get. We run the sheets of rubber and fabric together, one above the other, through great rollers pressing with an enormous force and traveling at different speeds; and these rollers actually squeeze the rubber into the fabric until the two are all one. As this rubber fabric comes out of the machine, it is cut into strips of just the right size for the tire we want to make.

When latex has been sprayed into a very hot room, the rubber that is left when the water evaporates has very much the appearance and texture of angel food cake. It is shown in the picture at the left.

Photos by U.S. Rubber Co.

At the right a cargo of latex is being discharged from the steamer into railway tank cars at New York. Now it will go to the factory to be made into rubber. Usually the latex is made to yield up its rubber before shipment.

How Auto Tires Are Made

Right at hand we have an iron core that is just the size of the inside of the tire. Over this core we fit several strips of our prepared fabric; and then we proceed to fit on layer after layer, one of rubber and another of fabric, until we have made the casing as thick as we want it. The fabric gives the strength, of course, and the rubber provides the springiness. When the casing is complete, the whole thing gets a thick covering of rubber on the outside. Then it goes into a mould which, under high pressure, shapes the outside rubber into the particular pattern of "tread" which is thought best to keep the tire from skidding. And in this mould the outside rubber receives its final vulcanizing and hardening. It is now ready for the car.

If you will cut through an old tire that you may find in some vacant lot, you will see the result of all these processes. Of course there are still many other ways of

Photos by U. S. Dept. of Agriculture, and the National Museum

On the banks of a stream in far-off Bolivia these bales of Para rubber, the finest kind of all, are waiting to be shipped thousands of miles to the factory. In the inset is a picture of Charles Goodyear, who discovered how rubber can be treated to make it hard and capable of resisting heat and cold.

effecting rubber treatment and working.

Rubber can be used again and again, and the scrap dealer does a good business in it. In fact, if we could not use our old rubber over again, we should not have enough of it in the world for all our needs. When old rubber comes back to the mill, it has first to be de-vulcanized—that is, to have the sulphur taken out of it, and any other substances that have been put into it. Then it is ready to be worked over once more.

How Artificial Rubber Is Made

When Japan seized the East Indies in 1942 she cut off ninety percent of the world's rubber, and gravely threatened our war program. For rubber tires are one of the first necessities in modern warfare. At once our government took steps to build plants for making synthetic (sĭn-thĕt′ĭk) rubber—that is, rubber made, not from latex, but from the various chemical substances which make up natural rubber. Germany had begun to make a synthetic rubber—called Buna (bū′nȧ)—during the First World War. To produce it her chemists combined limestone and coal to form calcium carbide, which in turn, when combined with water, yielded acetylene (ȧ-sĕt′ĭ-lēn), a gas often used for illumination. From acetylene was made butadiene (bū′tȧ-dī-ēn′), a gas very much like isoprene (ī′sô-prēn), the basic substance in natural rubber.

Later Buna was improved by the addition of a liquid called styrene (stī′rēn). They are combined by a process known as polymerization

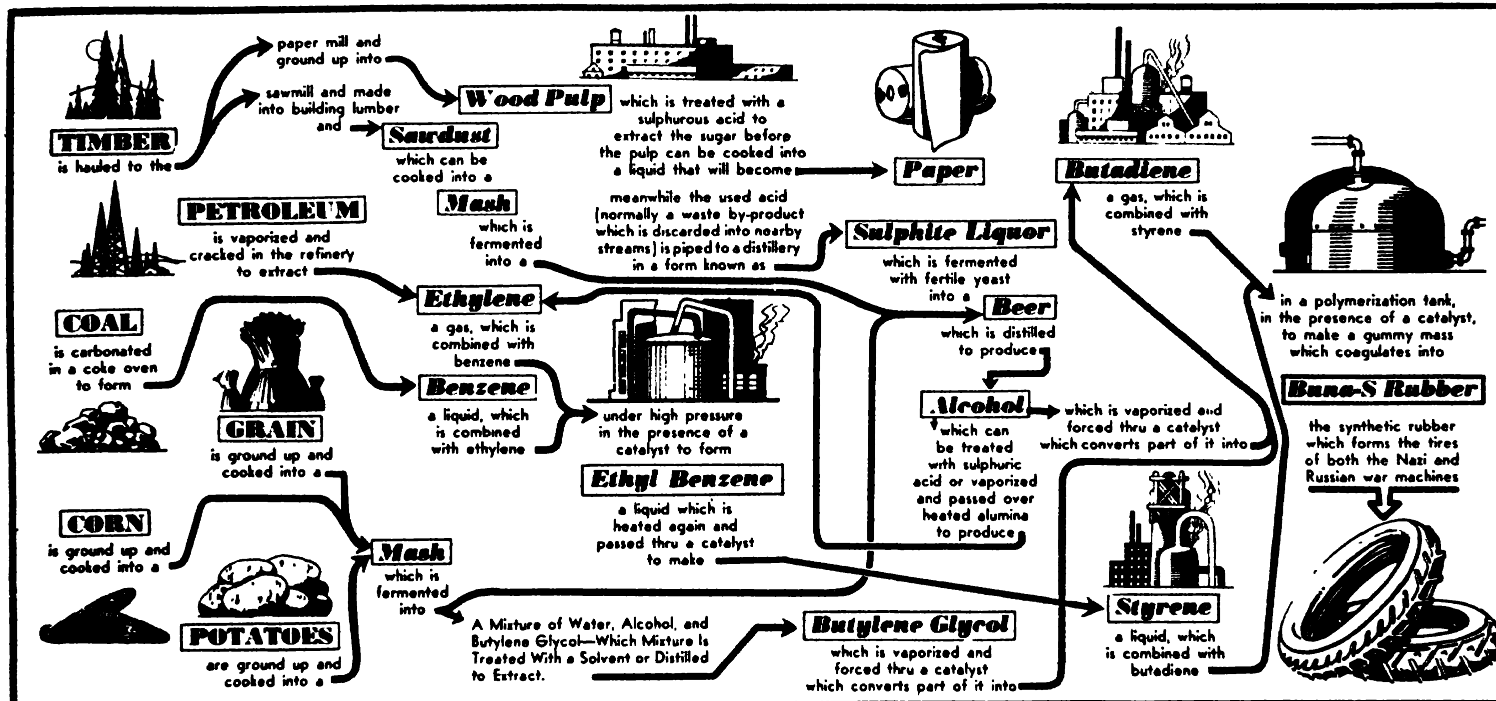


Photo by Chicago Tribune

There are countless substances from which artificial rubber can be made. Alcohol, one of its sources, is in its turn made from natural gas, wood, molasses, grains, potatoes, or almost any starchy vegetable matter. The interesting diagram above shows how certain common articles can be combined to form the butadiene and styrene which are united—three parts of butadiene and one part of styrene—to make Buna-S, our commonest artificial rubber. One cheap source of alcohol is sulphite liquor, a waste by-product in factories where wood pulp is made into paper. Butadiene can also be made from a mash of grain, corn, and potatoes. The mash when fermented yields a mixture of water, alcohol, and butylene glycol. The butylene glycol is extracted and from it butadiene is made.

In this country we usually make styrene from coal, for that is the quickest way to get it—for the same reason we make butadiene from petroleum—but styrene may be made from other substances also, among them petroleum. The diagram will show the main steps in the process by which styrene is made from a combination of benzene—a liquid derived from coal—and ethylene (ĕth'ĭ-lēn), a gas that may be obtained either from alcohol or from petroleum. When petroleum is its source the oil is "cracked"—that is, heated to a point at which one or more of its constituents may be extracted.

In their search for substances from which to make rubber the scientists have not forgotten that natural rubber is made from the juice of a tree. They have searched the vegetable kingdom for other plants that will yield latex or a similar substance. There has been a good deal of experimenting with certain of these plants, such as milkweed and goldenrod. Among the most promising are a shrub named guayule (gwa-ū'lĕ), which grows in the Western United States, and a Russian dandelion called "kok-sagyz." Unfortunately it would take a number of years to develop either of these sources of latex into an industry.

No one but the laboratory scientist can realize the years of experiment that have gone into the perfecting of any one of the processes for making artificial rubber. The scientists working for the great rubber company that put Ameripol on the market experimented with over 5,000 synthetic rubbers before they selected Ameripol as the most promising one to give to the public to use in automobile tires.

(pŏl'ĭ-mẽr-ĭ-zā'shŭn)—that is, the molecules in the two substances are hooked together into chains to produce an elastic, springy mass. They refuse to hook together without the presence of a third substance, known as a catalyst (kăt'ȧ-lĭst)—that is, a substance that produces chemical changes in other substances without any change in itself. The catalyst in this process has been kept a secret.

Buna-S—or Buna plus styrene—is the commonest artificial rubber, and was the one chosen in 1942 to furnish seven-eighths of the rubber to be produced by our government's $7,000,000 synthetic rubber program. It can be made in large quantities more easily and more cheaply than any other artificial rubber, and except for the very finest grade of natural rubber it is the best thing there is for tires. The best natural rubber gives ten percent more mileage, but since the quality of the workmanship counts more than the material the difference in the rubber is relatively of less importance. It still is true, however, that tires for heavy trucking should be made of natural rubber—as should surgeon's gloves and similar delicate articles.

When butadiene is combined with a substance called acrylonitrile (ȧ-krĭl'ō-nī'trĭl), instead of with styrene, we get a rubber called Buna N, or Perbunan. It has high resistance to the action of oils.

Making Rubber from Petroleum

Butadiene can be made from countless different raw materials—from petroleum, from coal and limestone, or from alcohol. The whole problem in making artificial rubber profitably is to find cheap substances and methods for making butadiene, for the labor costs only one percent of what it costs in making natural rubber. In this country we use mostly petroleum for making butadiene

But there are also other sorts of artificial rubber. Ever since 1932 various kinds of rubber goods, such as gasoline hose, conveyor belts, automobile parts, gloves, and stoppers, have been made from neoprene (nē'ō-prēn), a rubber made from acetylene. In this process butadiene is replaced by chloroprene (klō'rō-prēn), a similar substance. Though more expensive, neoprene has certain advantages over real rubber—it withstands heat and sunlight, can resist oil and various chemicals, and will wear longer. The basic substances from which it is made are coal, lime, and salt.

When petroleum is used as a source, butadiene may be made directly from the oil or from butane (bū'tan) gas, a cheap by-product that we get when petroleum is made to yield gasoline. A rubber known as Ameripol, or "liberty rubber," has been made from butane and combined with natural rubber to make tires that are tougher than those made from natural rubber.

The Rubber for Inner Tubes

Another synthetic is called butyl (bū'tĭl) rubber. It is made by a simpler process than any of the others, and while it has less bounce than the rest, it resists oil, air, and most chemicals. Its source is isobutylene (ī'sō-bū'-tĭ-lēn), a gas given off in the refining of petroleum. This is polymerized at once to make rubber. Both process and raw materials are cheap.

Butyl is the best of all rubber for the inner tubes of tires. It does not tear easily and it keeps flexible at very low temperatures. Inner tubes made of it will hold the air ten times as long as tubes of natural rubber. They have to be inflated only three or four times a year, and they run nicely for miles after they have been punctured. Butyl is also excellent for electric insulations, for making hose and draperies, and for waterproof clothing and tents.

A Rubber for Every Purpose

The future of synthetic rubber depends on its cost. Many experts believe that it can be made as cheaply as natural rubber. At any rate it has come to stay, for though no single synthetic rubber is so good as natural rubber in every way, taken together the synthetic varieties can do more things than natural rubber can. So each synthetic will have its own particular work to do—as will natural rubber also. The making of artificial rubber will probably become a great industry. For the natural rubber industry, which is centered in Akron, Ohio, has long been one of the richest in the world, with the United States producing about half of the world's supply. How surprised Columbus would be!

HOW WE MAKE PAPER

Reading Unit
No. 3

THE SECRET OF THE WASP

Note: For basic information not found on this page, consult the general Index, Vol. 15.

For statistical and current facts, consult the Richards Year Book Index.

Interesting Facts Explained

Which animals can make paper? 9–273
What materials were used for writing before the discovery of paper? 9–274
Who were the first men to make paper? 9–274
The main source of paper, 9–276
Hand-made paper, 9–276
Machine-made paper, 9–277
Rag paper, 9–277
Sizing and coloring paper, 9–280

Things to Think About

How has paper helped civilization?
How does the supply of cheap paper affect the spread of news?
How much wood does paper take from our forests each year?
Why does some paper crumble and turn yellow?
Could a democracy succeed without a plentiful supply of cheap paper?
What made the modern newspapers possible?

Picture Hunt

What did the ancients use for writing material? 9–274
How is pulp changed into paper? 9–278-79

Related Material

What was the earliest kind of paper made? 10–43
What was the first book printed in America? 7–79
How is artificial wood made from wood pulp? 9–294
Which was the first American newspaper? 10–74
What was our forest acreage originally? 9–257

Practical Applications

How has paper replaced certain other materials? 9–275
Why are different kinds of paper made? 9–274-77

Leisure-time Activities

PROJECT NO. 1: Make some pulp, 9–276-77.

PROJECT NO. 2: Make paper from pulp, 9–277-78.

Summary Statement

Paper is one of our most important vehicles for transporting ideas. Our civilization could not exist without it.

The first paper ever made looked like this—and here is a picture of its maker. You will notice that it is not a Chinese, as it is always said to have been. Instead, it is a touchy little wasp. So many years ago that no one can count them, she had a thriving industry for the manufacture of her stout gray building paper. Nowadays she has lost the monopoly, but she still is as busy as ever.

Photo by Cornelia Clarke

The SECRET *of the* WASP

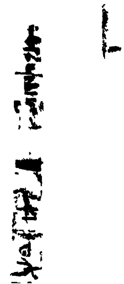
She Has a Good Many, and Not All of Them Are Pleasant, But the One That We Have Used Most Is Her Way of Making Paper

A FEW million years before man ever found out how to make a piece of paper, there was a little animal that knew all about it. This was the wasp. She knew just how to bite off bits of wood from a dead tree and chew them up to a pulp in her mouth; and then how to plaster them together into her fancy paper nests whose beauty we may all admire to-day—at a little distance. How the wasp ever found it all out is just a mystery—one of the million mysteries as to how all of the animals found out all the cunning things they know how to do. Somehow nature whispered the secret in her ear, so to speak, very long ago. And the wasp never forgot it.

It was only about two thousand years ago that man found out how to make paper. Before that he had used many other things for writing. He had carved his words on stones and cut them into clay bricks—doing very slow work and making very heavy "books"; and yet there were such things as libraries of those books. Then in Egypt he learned how to make something to write on out of the plant called papyrus—from which comes our word for "paper." He cut thin strips from the stem of the papyrus reed and laid them on a board; then he put other strips over them crosswise, soaked them all in water, pressed them together, and dried them in the sun. When the sheet had been well polished it made a good surface to write on. It could not be folded well, but it would roll up, and there were large libraries of books in rolls. Legal documents were written in rolls, and lists of names, as of soldiers; and to this very day we still call the "roll."

That was the main thing that the Greeks and Romans had to write on. They never saw a piece of paper. To be sure, they also

used the skins of beasts, properly prepared and tanned, for writing. This too was an old custom; and there is a story that it was revived, because of a lack of papyrus, by the king of Pergamum, in Asia Minor—and that from Pergamum we get the word "parchment." From the skin of the sheep we make parchment, and from that of the calf we make vellum. Little by little parchment and vellum displaced papyrus, and during the earlier Middle Ages they were the main things used. Very beautiful books were made of them—books that our big libraries and some few private collectors are now very proud to buy for a fortune. And parchment has never wholly gone out of use, in important documents. When you graduate from college you may get a diploma on parchment—which is why a diploma is called a "sheepskin."



Civilization owes a good deal to these little calves. They gave their soft, firm skins to make vellum, a very fine leather that for centuries was used instead of paper. The beautiful Venetian manuscript in the center below was made on vellum in 1474.

Above are two rolls of ancient papyrus, the Egyptian substitute for paper. It was made from the papyrus plant, a water plant with pithy stems that were full of firm fibers. It must have taken a great many of those slender stems to make a piece of paper of any size; and slicing them up and pressing them together into a solid, even sheet must have been delicate and tedious work. The little plant that did such good service in the cause of civilization is shown at the left of the rolls.

...tos by Metropolitan Museum of Art, ... and U.S. Dept. of Agric.

The sheep above has done his bit, too, in helping to spread learning. His skin made the parchment, or "sheepskin," that lasts so long. To the right is a fifteenth century Italian manuscript on parchment.

Yet all this while there was paper in the world, though the Greeks and Romans and the people in the early Middle Ages did not know it. The paper was in China, where the secret of the wasp had been found out some two thousand years ago. But for about a thousand years the Chinese managed to keep the precious process secret. Then the Arabs learned it, a little before the year 800, perhaps from some Chinese captives they took in battle; and the Arabs brought it across the north of Africa and into Spain. It reached Spain by the twelfth century, and then spread over Europe, and by the year 1400 paper was in common use, though parchment had by no means gone out. Thus by the time when printing came, with the demand for large quantities of paper, the paper was all ready at hand.

Since that time we have learned a great deal about making paper—making it out of more and more things, making it into more and more kinds, making it better when we need it and cheaper when we want it so, and above all making it faster and in quantities of which the first printers would have never dreamed. For a long time it was all made by hand, but for more than a century now it has been made

Photo by Warren Paper Co.

Not much like paper, this great pile of wood! And yet it is all going to be turned out as thin white sheets that you and I will read the morning's news from while we drink our coffee at breakfast.

mostly by machines which turn out thousands of times as much as we used to have.

We have writing paper so fine that not an atom of ink will sink into it, and blotting paper so thirsty that it will drink up every drop of ink it touches. We have wrapping paper so heavy and strong that we can hardly tear it or punch a hole in it, and tissue paper so flimsy that we can roll up a big sheet in a pellet or blow the sheet across the room in a breath. We have carbon paper for our typewriters, tar paper for the roofs and walls of our houses, wax paper to wrap up our candies, oil paper that can be left out in the rain all night, and paper boxes that are strong enough to ship around the world. We have fine paper to write our letters and still finer paper to print our bank notes on; and we have cheap paper in our tablets - use no ink!—which have taken the place of the big slates that children used to carry to school years ago. We have paper for important books and documents that is meant to last for many a century, and we have paper that will turn yellow and crumble in a month, because it is meant to be used once and thrown away. And we have still hundreds of other sorts of paper.

Above all, at least for quantity, we have the vast rolls of paper on which we print the daily news. The thing that brings us the news twice a day is so familiar that we just call it a "paper." But what a thing it is! For a single edition of one of our big Sunday papers will use enough sheets of paper to make a belt all the way around the world. That is what has come of the secret of the wasp.

So it is hard to think of anything much more important for us than our paper. To say nothing of its other uses, nearly everything that gets into our brains comes to us on paper; for even if someone else tells us about it, it came to *him* on paper, or to the man who told him. Our brains live on paper as our stomachs live on bread and meat. Paper is a cornerstone of civilization.

What Paper Is Made Of

If it is so important, we ought to know what it comes from and how it is made. Many people have a rather hazy notion about this.

Paper can be made of almost any fibrous stuff. The Arabs used to make it out of linen and flax and rags, or out of various vegetable fibers. We still use all of these things and many others—hemp and jute, cornstalk, straw, old rope, bamboo, a kind of grass from Spain called "esparto," and still further things. But the main thing we now use for paper is the thing the wasp

always used. It is wood. For our paper we cut down thousands of square miles of trees in the forests every year—spruce, hemlock, pine, aspen, poplar, and still other kinds.

It is true that wood does not make the very best of paper. The finest writing paper, and any paper that is meant to last a long time, is made of something else—mainly of linen and rags. The trouble with wood paper is that it turns yellow and crumbles with age, especially in a strong light. We all know how yellow an old newspaper gets, and we have seen some of our old books turn the same color, even when they were closed to the light. Yet we could never have enough rag paper to do all our work, and wood paper is just about as good for a newspaper or even for a book that is not expected to be immortal—as very few are. Even so, at least one of our great newspapers prints a few copies every day on good rag paper and stores them away as a record for the historians in the years to come.

Photo by British Museum

How should you like to have your newspaper come in the shape of heavy clay bricks, like this cuneiform inscription from ancient Babylon? No wonder people had no journals in those days! It is partly the newspaper's handy form that makes it possible for everyone to read it. And it is due largely to the fact that everyone reads it that we have our modern democratic governments. The logs that have been turned into paper by a single company in the past twenty-five years would make a belt four feet wide and four feet high all the way around Mother Earth at the Equator, with enough left over to tie in a neat bow knot. And the sheets in a single edition of one of our great Sunday papers would reach around the world.

The Best Paper Is Made by Hand

Just as the vast amount of our paper is made of wood but the very best from rags, so the vast quantity is made by machine but the very best by hand. Before we tell how the machines turn it out we ought to say a word about how it is still made by hand.

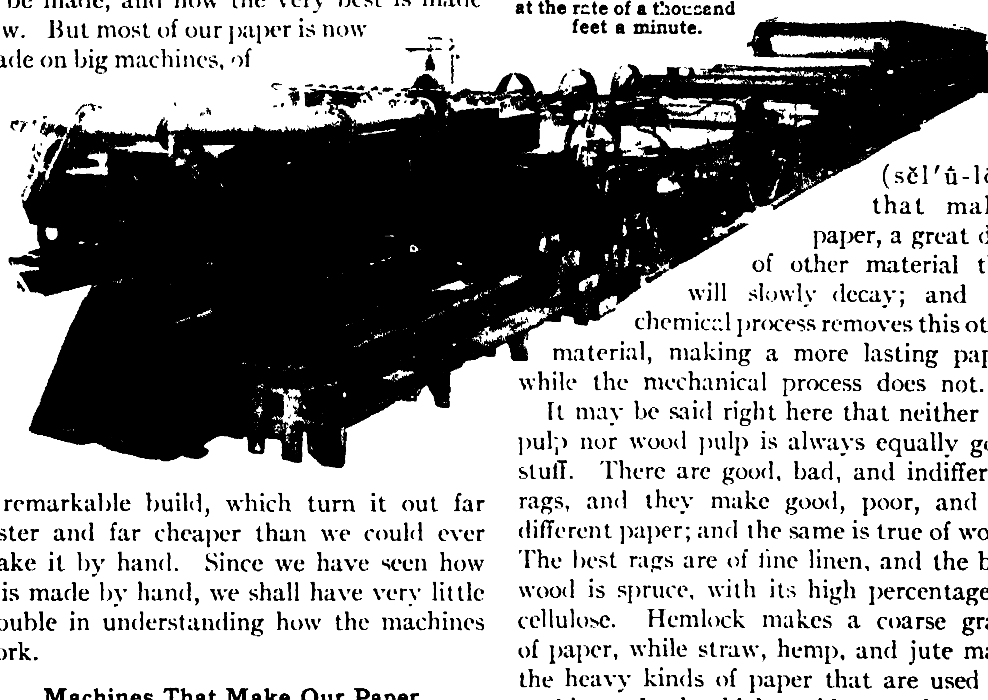
How Paper Is Made by Hand

Anything that is going to be made into paper must first be chewed into a pulp. The wasp knows that. For it must be poured out into sheets, and it must be pulp before it can be poured. Now the pulp for handmade paper comes from linen and cotton rags—from our old clothes as collected by the rag man and from scraps from the factories. When these have been all ripped up and cleaned and bleached to take out every chemical, they are cut up into little bits, thrown into a vat full of water, and beaten into pulp. Then they are a mass of loose fiber floating in water.

The pulp is strained to get out any tiny lumps that may be left in it, and then it is ready for the paper maker. He has a mould of very finely woven wire, just the size of the sheet he wants to make. He dips this into the pulp and draws up enough for a single sheet. A wooden frame around the mould keeps the pulp from running over the sides, but the fine wire lets the water drip through and leaves a sheet of wet paper on the mould. All the while the man is shaking the mould gently to and fro to make the

fibers settle into a firm, even sheet. Then each sheet is placed between two layers of felt, and a pile of them is put into a press to squeeze out nearly all the water that remains. In the wire mould there has been a design called a watermark, and the paper already bears the impression of it. Finally the paper is ready for "sizing"—that is, for dipping into a tub of gelatine or some other gluey stuff which fills the pores and allows a good hard finish that will take ink. Without the sizing our paper would be soft and spongy, like a blotter, or like the kind of paper on which we can use nothing but a pencil.

That, in brief, is about how all paper used to be made, and how the very best is made now. But most of our paper is now made on big machines, of a remarkable build, which turn it out far faster and far cheaper than we could ever make it by hand. Since we have seen how it is made by hand, we shall have very little trouble in understanding how the machines work.



This is the deft machine that in one continuous process turns soft wet wood pulp into smooth firm paper. The pulp, all ground and bleached and otherwise prepared, is fed into it at one end, and comes out at the other end, 250 feet away, in paper rolls at the rate of a thousand feet a minute.

Machines That Make Our Paper

The main paper machine came to us from France, about 1798, and bears the name of Fourdrinier (fo͞or′drē′nyā′). Of course it has been vastly improved and enlarged since the time when he first introduced it into England. A big machine may now be as much as 250 feet long and may turn out over a hundred tons of paper in a single day.

Again we have great vats of pulp. If it is rag pulp, it is beaten up in the water with whirling machinery. If it is wood pulp, as commonly, it is made in either of two ways. The logs that come to the mill, after all bark and knots are removed, may be simply ground to fibers and run off into the vats with water. This makes "mechanical" pulp, which is the cheapest kind. Or the logs may be reduced to chips and put to soak in a hot bath of chemicals—mainly bisulphite (bī-sŭl′fīt) of lime—in a big cylinder called a "digester." This makes "chemical" pulp, a good deal better kind. The reason it is better is that all wood contains, along with the cellulose (sĕl′ū-lōs) that makes paper, a great deal of other material that will slowly decay; and the chemical process removes this other material, making a more lasting paper, while the mechanical process does not.

It may be said right here that neither rag pulp nor wood pulp is always equally good stuff. There are good, bad, and indifferent rags, and they make good, poor, and indifferent paper; and the same is true of wood. The best rags are of fine linen, and the best wood is spruce, with its high percentage of cellulose. Hemlock makes a coarse grade of paper, while straw, hemp, and jute make the heavy kinds of paper that are used for packing. It should be said, too, that very little paper is made of only one kind of pulp—except the finest rag paper. Newsprint is usually mechanical pulp, while paper for all but the cheapest books is chemical pulp or a mixture—with a little rag pulp in only a few of the very finest.

How Pulp Is Turned into Paper

In these ways we make our pulp. It takes a good while. But we turn the pulp into paper far faster. What was a mass of

HOW WE MAKE PAPER

Here on these two pages is the life history of the paper that you are this moment looking at. First it grew as a fine spruce tree (A). Then, with its fellows, it was cut down, sawed into short lengths, and stacked in a pile, ready to be shipped to the mill. At the end of its journey it went into a revolving drum (B) in which were projecting blades that cut away the bark.

A conveyor carried it to a chipper (C), where it was cut up into small chips.

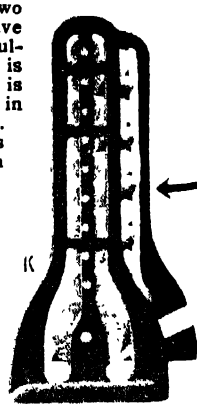
The chips then went to a "digester" (D), where they were cooked under pressure in acid for about 8 hours.

Next, the "digested" mixture passed to a beater (E) and there was churned into a smooth liquid which was pumped to a "Jordan chest." There, in a big tank, revolving blades kept it from settling, while "fillers," like talc or china clay, were added, and perhaps a "sizing" in the form of liquid rosin.

Next, it was passed to the Jordan engine (F), where the fibers were cut into even lengths.

From the Jordan engine the smooth wood pulp passed to the feed box (G), shown at bottom of next page.

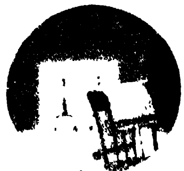
On these two pages we have shown how sulphite paper is made. That is the kind used in these books. Other kinds are made in other ways.



All the steps in making paper which we have shown on this page take place in one continuous machine. We have dissected it that you may see what happens.

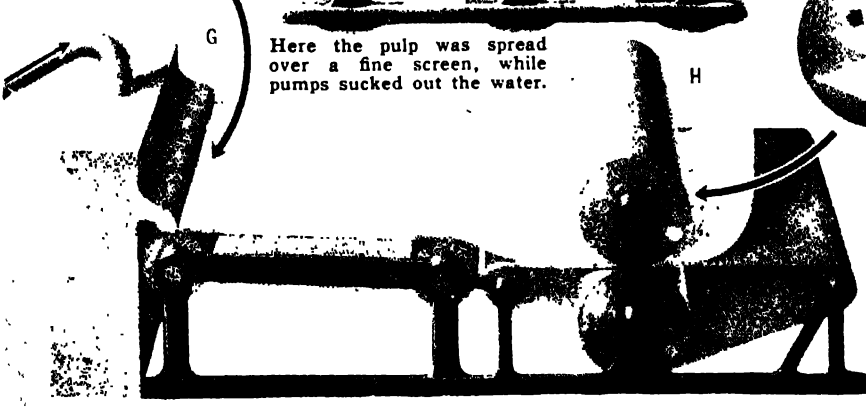
There are certain cleaning and bleaching processes that take place at various stages in the operation of paper making, but those we have not illustrated

Now the paper is ready for the ironing machine, which is called a calender stack (K). There it is ironed smooth. The more rolls there are in the stack, the smoother the paper becomes. At last the finished product is rolled up, ready to be made into the book you are holding in your hands.



The stack of rolls (J) that it went to next were heated inside with steam. These "drying rolls" took out the rest of the water.

When the paper was fed through a set of steel rollers (I), it was squeezed still drier and made firmer still.



Here the pulp was spread over a fine screen, while pumps sucked out the water.

The thin sheet of pulp next passed through a pair of felt rollers (H) that took up more water, like a blotter.

Courtesy National Film Board

The milky mixture in this flow box of a Canadian newsprint factory contains sulphite wood pulp and wool in water. Forests of spruce, balsam, and hemlock make Canada one of our greatest producers of newsprint.

milky pulp in the vat may be turned into rolls of finished paper by our great machines in just about a third of one minute!

Out of the vat, through a series of processes, the pulp runs as a filmy sheet or "web" upon a fast-moving belt of fine copper-wire mesh, which of course takes the place of the old mould used for handmade paper. The belt carries it along, letting the water drip out of it and also drawing the water out by suction; and it shakes the pulp a bit from side to side, just as the hand paper maker used to shake it, to settle the fibers firmly. Of course the drippings return to the vat. Toward the end of the trip on the wire belt the sheet passes under what is known as the "dandy roll" and receives a watermark. Then it runs off the wire and through a number of press rolls which take out still more of the water and press the paper more firmly together; and now, looking very much like paper, it goes over various heated drying rolls and various calendering rolls, to give it whatever smooth or glazed finish is wanted, and is finally wound up on big reels, ready for the printing office. Of course the machines will cut it to any size of sheet desired.

The coloring matter, which may come from many kinds of substances, is simply added to the pulp. It may gets its "sizing" in the vat, or later the machine may dip it into a tub of "sizing," depending on what kind of material is used for the purpose. A good many things are also commonly put in as fillers, to give the paper a good body—China clay, talc, rosin, and even finely-ground glass. All these things vary with the kind of paper we are making.

The paper industry is an enormous one. Every year we cut down thousands of square miles of timber for our paper—enough to make a strip of paper some 150 feet wide and reaching from here to the sun. In all this the United States is the leader. She makes and uses some two thirds of all the paper in the world—mostly because of the great number of uses to which she now puts paper in industry and in common articles of everyday life. At the rate at which things are going there is grave danger that the world may one day face a paper famine, such as we had in World War II for lack of men to fell the trees. But if we plant enough trees in place of those we cut down we shall probably always have enough paper. Of course we could save a great deal of paper by not printing so much worthless stuff. But it is not always easy to tell what is going to be worthless—especially if you write it yourself.

Reading Unit No. 4

COULD YOU MAKE A ROPE?

Note: For basic information not found on this page, consult the general Index, Vol. 15.

For statistical and current facts, consult the Richards Year Book Index.

Interesting Facts Explained

Why ropes do not unravel, 9–283-84
Materials out of which ropes have been made, 9–283-84
The best material for rope, 9–285
Making rope, 9–287
The first American rope maker, 9–288
How much rope-making material do we import? 9–288
Sources of hemp and Sisal, 9–285-86
The difference between rope and cord, 9–288

Things to Think About

How do plants give us the rope we need?
How is a rope made pliable?
Where are real hemp ropes still in use?
How would the lack of rope affect civilization?
Can you think of a good substitute for rope?

Picture Hunt

What do rope-making machines do? 9–286
How are plants changed into rope? 9–282-83

Related Material

How are certain ferns used for making rope? 2–92
How is esparto grass turned into rope? 9–291
How are ropes used on sailing vessels? 10–171
How do primitive people use hand-woven fiber ropes to build bridges? 10–209
How are steel ropes used to support bridges? 6–240
How are ropes used in elevators? 1–337
Why are ship hawsers protected from rats? 4–384

Practical Applications

How large are the hawsers which are used to raise sunken ships? 9–288
How does the farmer use Sisal cord? 9–285

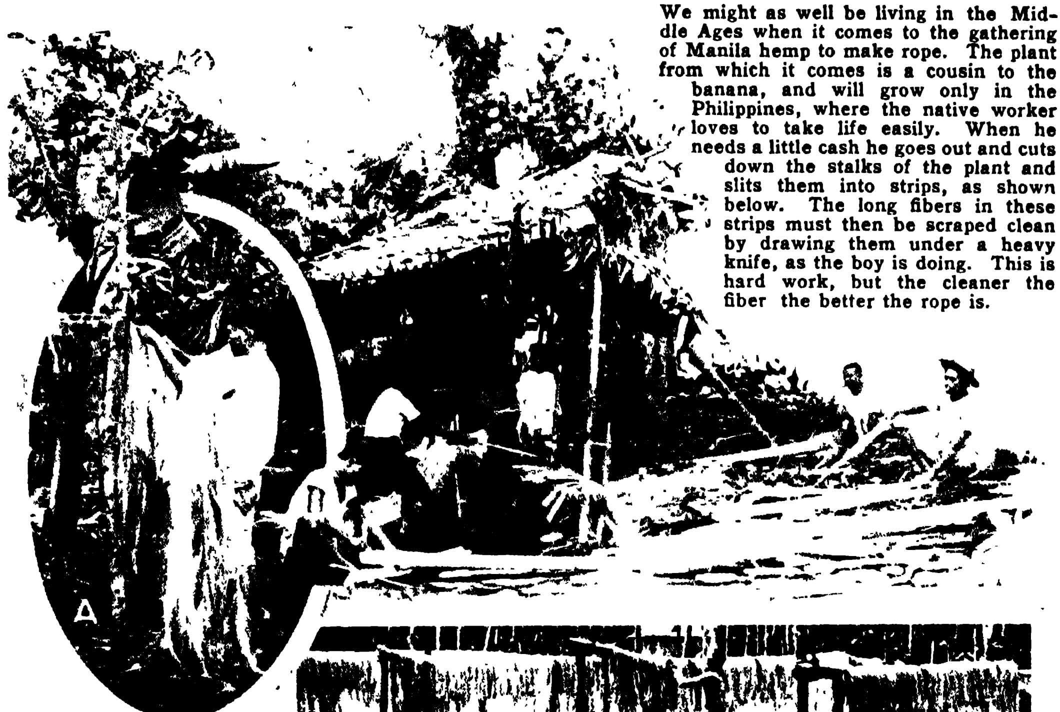
Leisure-time Activities

PROJECT NO. 1: Weave a rope from some fiber, 9–283-84.
PROJECT NO. 2: Make a display which shows the difference between string, cord, rope, hawser, and cable, 9–288.

Summary Statement

Man twists animal and plant fibers into ropes which help him to tow, tie up, and support things.

THE STORY OF ROPE



A

We might as well be living in the Middle Ages when it comes to the gathering of Manila hemp to make rope. The plant from which it comes is a cousin to the banana, and will grow only in the Philippines, where the native worker loves to take life easily. When he needs a little cash he goes out and cuts down the stalks of the plant and slits them into strips, as shown below. The long fibers in these strips must then be scraped clean by drawing them under a heavy knife, as the boy is doing. This is hard work, but the cleaner the fiber the better the rope is.

B

When the fiber is thoroughly cleaned, it is hung up to dry in the sun and air—as is shown at A and B—and then is tied up in long hanks. Now it is ready to be carried by any handy primitive conveyance to the boat that takes it to Manila. It may go by canoe or ox cart; at C it is being carried down from the hills on sturdy native backs. When it reaches Manila it is sorted as to grades (D). Whatever was well cleaned is pure white, but the rest is reddish or brown.

C

There is a fortune waiting for anyone who can invent a machine that will clean the pulp from the fiber of Manila hemp. So far nothing has been found to take the place of human hands. For that reason the process is long and tedious, and much of the hemp second-rate in quality.

D

Photos by Bureau of Agriculture, P. I.

Only think of all the bundles, from sheaves of wheat to Christmas presents, that this rope and cord and twine are going to tie up. If you do not know how they are all made, you will want to read this article and find out.

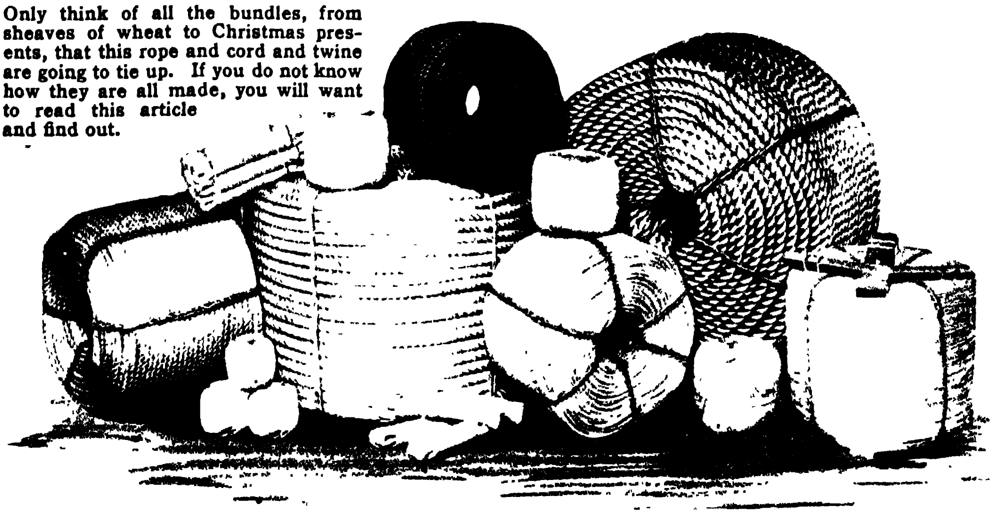


Photo by Whitlock Cordage Co.

COULD YOU MAKE A ROPE?

Of Course You Could Twist Threads, but How Would You Keep Them from Untwisting? This Will Tell You All about It

IF YOU want to hang a weight, or to hold anything at all that is pulling, you get a piece of string. If the string is not strong enough, you can get two or three pieces, or as many more as you need. But you know well enough that it is clumsy to hang a thing with several pieces of string. So what you do, without even thinking about it, is to twist the strings together into one big string. Then they hold together and make your business a great deal easier.

But if you just twist your strings around one another in the easiest way, they will all untwine as soon as you hang your weight to them, and you will have several strings again instead of a single one. So you have to twist one of your strings one way and another in the opposite way, and so on for all the strings you are using. Then they will not untwine, for they will be pulling in opposite directions, and the different pulls will equalize or neutralize each other.

As soon as you have done this, you have made a sort of rope. For that is all a rope is—a set of strings, however many, all twisted around one another in such a way that they will not untwine but will remain one cord.

Who was the first man to do this we shall never know. He is lost in the mists of ancient time; for good ropes were made long before the dawn of history. Maybe a grapevine gave the first man his idea, and there are still some savage tribes that build pretty strong bridges out of vines. But many other things were used as time went on—strips of hide, slivers of bark, reeds and rushes and roots, hair from animals that was spun and twisted into cords, and many another substance. To this day we can use things like these to tie up our bundles, or even to make fishing lines, when we are out in the wilds and run short of string.

So the savage tribes of long ago had learned how to make cords and rope, and very beautiful and strong ones. The American Indians made rope out of a dozen things, from cotton and tough roots to the skins and hair of the beasts in the forests. The natives of other places used whatever was best and most abundant in their own lands—the fibrous bark of certain trees, the tough

Photo by National Museum

We owe the invention of rope to men so far back in history that we don't know when they lived. Here, Indians in New Mexico are busy making a rope as gay as their blankets.

stalks of certain weeds, the wiry strips of the strong leaves of certain plants like the palm, the tendons and sinews of certain animals. Thousands of years ago the Egyptians were making ropes out of papyrus, the plant from which we get the name for paper, and their ropes were strong enough to haul the great stones that went into the pyramids. The Greeks and Romans had great ropes for rigging their ships and for anchoring them; and when Xerxes brought his army from Persia over into Greece in 480 B.C., he built a great double bridge of boats across the Hellespont for them, nearly a mile long, and fastened it up with enormous cables. We are told that there were a dozen of the cables, each twenty-eight inches around, and that half of them were made of flax and half of papyrus.

Thus were ropes made, great and small, in the days of old. Always the process was really the same. Some sort of strong stuff was found and spun into strings. Then the strings were twisted into a rope, as many as were needed to make the rope big enough and strong enough for its purpose. And the strings were twisted in opposite directions—one with a left-hand turn and another with a right-hand turn—to keep the rope from untwining. That was all. That is all there is to any rope, except detail. And all our progress since those early days, however important, has been in detail. We have found better and better things for making rope, better and better ways of treating the things we use, and of late we have made great machines to do nearly all the work better and far faster than it used to be done by hand. About all that we are now going to talk a little. But the essential process is still the same. It is just twisting strings in the right way; and anybody can therefore make a pretty good rope for himself, if he cares to take the trouble.

First, what are the best things we have now found for making rope? There are still a good many, and we shall mention only the main ones.

One of these is Manila hemp, or abaca (ăb′-å-kä). It is not hemp, and is called that only because so much of our rope used to be made of hemp before this product came to us. We just thought of it as a new kind of hemp, and named it for Manila because that is where it comes from. Manila hemp is the fiber from the wild banana plant that grows only in the Philippine Islands. This plant grows into a little palmlike tree, some twenty feet high, and its trunk is made up of the leaf stems that have kept overlapping one another as it grew up. The strong fiber is in the outer bark of these leaf stems, which are peeled off layer by layer and scraped free from the pulp attaching to them. When the fiber is cleaned and dried, it is packed into bales and is ready to go off to the rope factory.

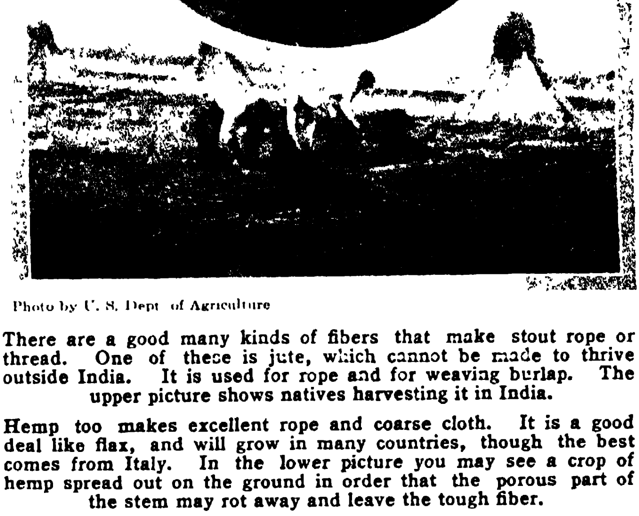


Photo by U. S. Dept of Agriculture

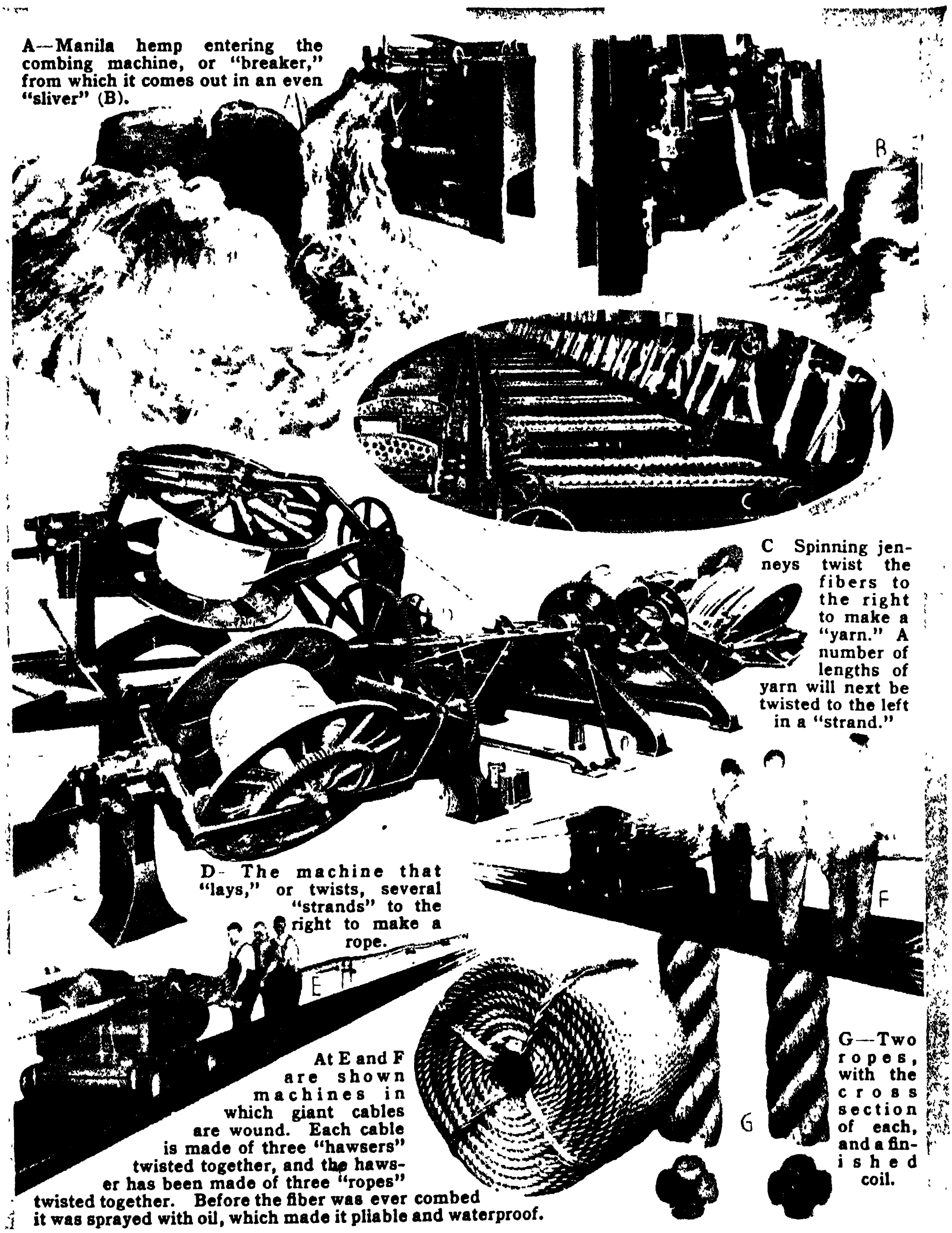
There are a good many kinds of fibers that make stout rope or thread. One of these is jute, which cannot be made to thrive outside India. It is used for rope and for weaving burlap. The upper picture shows natives harvesting it in India.

Hemp too makes excellent rope and coarse cloth. It is a good deal like flax, and will grow in many countries, though the best comes from Italy. In the lower picture you may see a crop of hemp spread out on the ground in order that the porous part of the stem may rot away and leave the tough fiber.

The second most important thing for making rope is what we call "Sisal fiber," or simply "Sisal." It comes from the leaves of a plant like a cactus. Formerly we got nearly all of it from Mexico, and especially from Yucatan, but now we can buy it from several other places, notably from Java and from East Africa. In these places there are great Sisal plantations where the plants are grown for about five years till their long, strong leaves are ready to cut. It is these leaves, with all the pulp scraped off, that give us the tough fibers which we make into rope. The plant keeps yielding the leaves for fifteen or twenty years.

Sisal and Manila hemp are rather different, and each has its own best uses. The fiber from Manila is longer, running from six to ten feet, while Sisal (sê-säl′) ranges from two to four feet. Of course length is an advantage. Sisal is also only about three-quarters as strong as Manila, and it is rougher and less pliable. When you get a "splinter" in your hand from a rope you are probably handling Sisal. And Sisal will not usually last so long as Manila. Yet it is a good material, especially for cords and ropes that will be used only for one time or only for a few times. So it is used widely in making cords that will be employed to tie up bundles and will probably be thrown away when the bundle is untied. That is why we use it for tying up many things like bundles of laths, and above all for binder twine. The invention of the reaper and binder made a great demand for twine, and a large part of the two hundred and fifty million pounds of Sisal annually brought into this country finds its way as binder twine into the wheat fields.

These are the two main things for making rope in our day, but there are still others. In older days we used to employ a great deal of true hemp, and we still use a certain amount of it. This hemp is a tallish plant that grows in Kentucky, and in Italy and Russia, and gives us a strong and workable fiber in its bark. It makes a fine rope, and



A—Manila hemp entering the combing machine, or "breaker," from which it comes out in an even "sliver" (B).

C Spinning jenneys twist the fibers to the right to make a "yarn." A number of lengths of yarn will next be twisted to the left in a "strand."

D- The machine that "lays," or twists, several "strands" to the right to make a rope.

At E and F are shown machines in which giant cables are wound. Each cable is made of three "hawsers" twisted together, and the hawser has been made of three "ropes" twisted together. Before the fiber was ever combed it was sprayed with oil, which made it pliable and waterproof.

G—Two ropes, with the cross section of each, and a finished coil.

Photos by Whitlock Cordage Co.

in the old days the Kentucky fields were famous for turning out the stuff that went into the rigging of many a gallant ship. But it has now been mainly replaced by the "hemp" from Manila and by Sisal, just as the sailing ship with its sheets and lines has been replaced by steam; and hemp rope is largely a thing of the past. Yet it is still used for the tarred ropes of many of the sailing vessels that remain to us.

Photo by Bureau of Plant Industry P. I

With the help of some crude machines these convicts in the Philippines are twisting Manila hemp into cord.

We also use a little New Zealand hemp or flax, which is not a true hemp either, but comes from the leaves of a plant that belongs to the lily family. And there are still other "hemps"—from Java and from Africa especially. Finally, besides a few other minor things, we use a certain amount of jute from India and of cotton from our own southern states. And of course we now make a good deal of wire rope for use on ships and in large hawsers and cables where the greatest strength and most lasting qualities are needed.

What Our Rope Is Made Of

The fact is that we can make rope out of almost any strong, stringy material, and that at one time or another we have made it out of a vast number of things. But for the most part we have now settled down to Manila and Sisal as the two best and most plentiful materials.

And how do we make the rope out of these? Well, we can show you this in the pictures a great deal better than we can tell you about it. Just remember that, as we said in the beginning, we have to get the fiber ready for spinning; then we have to spin it into long strings; and then we have to twist the strings around one another in such a way that they will not untwine when we let them go. That is the simple way to *tell* about rope making; and now if you will look at the pictures you will see all the complicated things that must be done, either by hand or by machinery, to turn the fiber into fine rope.

Rope in Industry

It is easy enough to describe to you how it all used to be done by hand, until less than a hundred years ago. A very skillful man would walk backward, with a bundle of fiber attached to his waist, and spin it out into a cord as he went; and in trip after trip he would go up and down the "rope-walk" turning out his product. In the pictures you will see all the machines that have now replaced this man and his fellow workers; and you can follow the history of the fiber from the time it is peeled off the

tree in the Philippines or in Mexico until the moment it comes out in twine or in great cables at the factory.

Of course all this is a very important industry, even though most of us do not often think of it. Every industry that is as old as rope making is of great importance, because it meets one of the primal needs of man. If we just try to imagine for a moment how we should feel if we had nothing to tie things up with, from the smallest bundle to the biggest ship, we shall see the importance of the cords and ropes that seem such natural things for us to have around. With one kind of cord or rope we tie up our bundles or fly our kites or make our swings; with another kind thousands of plying hands and machines are busy in the wheat fields. With other kinds we secure the masts on the biggest ships afloat or tow them to their docks and make them fast. With still other kinds, of iron or copper, we hold up suspension bridges across great rivers or lay cables under the ocean. We have come a long way from the first man who plaited a few pieces of string.

And that leads us to ask just what a rope is, after all. For we all know that a string or a thread is not a rope; so how big does a cord have to be before we can call it a rope? Well, when we twist several fibers together we make a thread. If we then twist two or more threads together--in the opposite direction—we have a strand. A few twisted strands, again going in the opposite direction, make a string, or twine. Thick string is called cord. Three or more cords twisted, or "laid," together make a rope. So a rope may be of different sizes, according to the kind of fiber it is made of, and the number of threads and strands and strings twisted into it; but anything from a half inch to an inch or more thick is commonly called a rope. Then if we twist three ropes together we have a hawser, and if we twist three hawsers we make a cable.

In America our fathers found that they needed a rope maker very early. So they sent over to England for a certain John Harrison, who came to Boston in 1630 to make rope for them. By the time of our Revolution there were over a hundred ropewalks in the country, and in the year when our constitution was adopted there were more ropemakers than mechanics of any other one kind. Of course the machinery has cut down the relative number of men who make rope, but the product has gone right on increasing. In 1843 we imported about 28,000 bales of Manila hemp, and in 1860, the first year of Sisal, we took in about 1,400 bales of that. Now we import hundreds of thousands of bales of each every year or hundreds of millions of pounds.

A coil of wrecking cable is much taller than a man, for the cable is often as much as two feet in circumference. It is used in raising sunken ships.

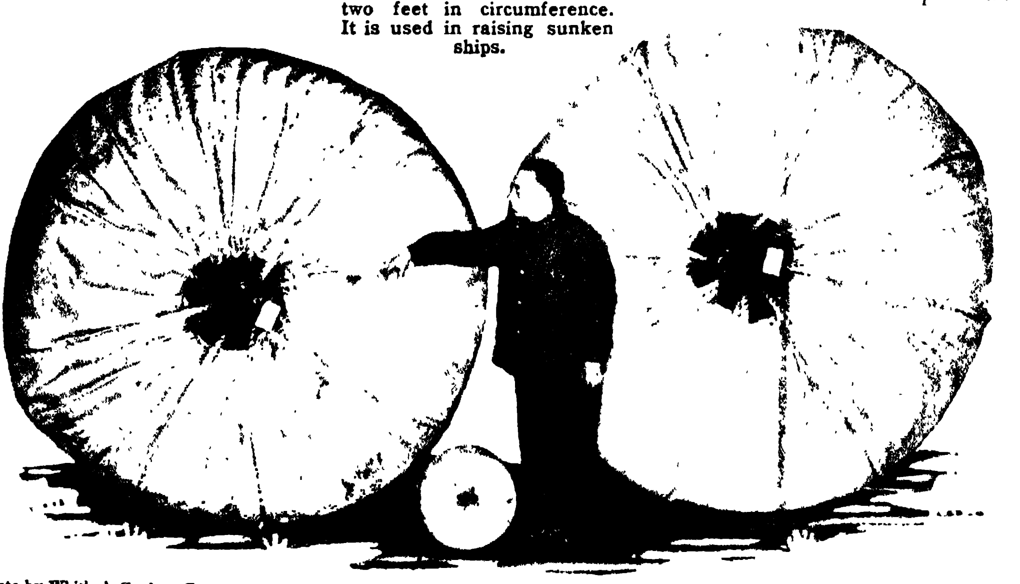


Photo by Whitlock Cordage Co.

SOME INTERESTING PLANT PRODUCTS

Reading Unit No. 5

GIFTS FROM THE TREES AND THE GRASSES

Note: For basic information not found on this page, consult the general Index, Vol. 15.

For statistical and current facts, consult the Richards Year Book Index.

Interesting Facts Explained

Esparto or "Spanish" grass, 9–290-91
Paper from grass, 9–290
A useful poison sumac, 9–290-91
Lacquer, 9–290-91
Chewing gum, 9–292
Cellophane, 9–293
Artificial wood, 9–294
Composition, 9–294

Things to Think About

Why is chicle being replaced by other materials in the making of chewing gum?
Why is lacquering an art?
How is wood changed into pure cellulose?
Why is lacquer better than paint for certain purposes?

Picture Hunt

How is chicle removed from a chicle tree? 9–290
How does chicle go to market? 9–290

Related Material

How is rope made? 9–283-88
How is paper manufactured? 9–276-80
How are lacquered chests and cabinets made? 12–192
Why are some baskets coated with gum? 12–131
How long do some trees live? 2–6, 159, 249, 253, 259-60
How do liquids flow in a tree? 2–237
How do birds damage trees? 4–73
How does rainfall affect tree growth? 2–197

Practical Applications

How is lacquer used? 9–290-91
Why is cellophane replacing other wrapping materials? 9–293

Leisure-time Activities

PROJECT NO. 1: How to make a cardboard house, 14–10.
PROJECT NO. 2: How to make a colored window with cellophane, 12–73.

Summary Statement

Trees and grasses furnish us with rope, lacquers, cellophane, chewing gum, and many other important products.

GIFTS *from the* TREES *and the* GRASSES

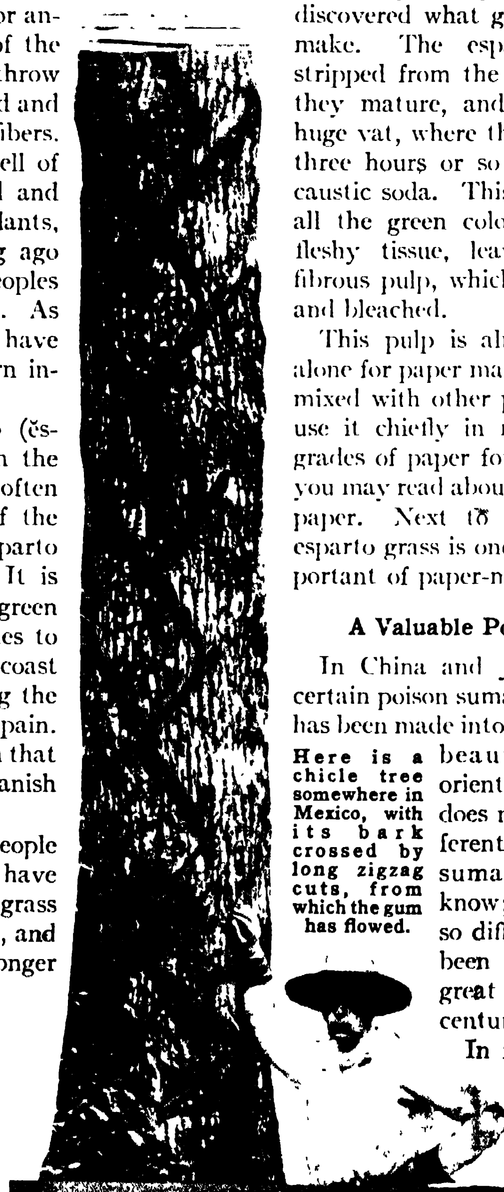
Here Are a Few of the Extra Presents That the Plants Throw in for Us after They Have Fed Us and Furnished Our Houses

WHAT is cellophane made of? Where does amber come from? What is the shiny lacquer which gleams on that little box made in Japan? These things all come from plants of one kind or another. They are only three of the odds and ends that the plants throw in after they have given us food and timber and medicines and fibers.

If we had time, we could tell of thousands of such unexpected and important products from plants, most of them discovered long ago by savages or half-civilized peoples who lived very close to nature. As it is, we shall speak of a few that have become very important modern industries.

Take, for instance, esparto (ĕs-pär′tō) grass. You have seen the pretty feathery-topped grasses often planted in gardens because of the brave show they make? Esparto grass looks much like that. It is coarse and wiry, with gray-green leaves anywhere from six inches to three feet long. It likes the seacoast countries, and grows well along the north coast of Africa and in Spain. In fact, it grows so well in Spain that it is often spoken of as "Spanish grass."

For hundreds of years the people of the Mediterranean lands have used the leaves of the esparto grass to make sandals, baskets, mats, and ropes, for it has a much stronger fiber than most grasses. The Spanish Navy uses it for ships' cables; it is so light that it will float on the water and yet so strong that there is no fear of a cable's breaking. The young stalks, also, make fine food for cattle, though as esparto grass grows older it gets too tough to be eaten.



Here is a chicle tree somewhere in Mexico, with its bark crossed by long zigzag cuts, from which the gum has flowed.

Photo by International News Photos

But nowadays the most important use for this stout grass is the making of paper. About a hundred years ago French scientists discovered what good paper it will make. The esparto leaves are stripped from the stem just before they mature, and are put into a huge vat, where they are boiled for three hours or so in a solution of caustic soda. This boiling removes all the green coloring matter and fleshy tissue, leaving a mass of fibrous pulp, which is then washed and bleached.

This pulp is almost never used alone for paper making; instead it is mixed with other plant pulps. We use it chiefly in making the finer grades of paper for magazines; this you may read about in our article on paper. Next to the spruce tree, esparto grass is one of the most important of paper-making plants.

A Valuable Poison Sumac

In China and Japan there is a certain poison sumac with juice that has been made into some of the most beautiful pieces of oriental art. This plant does not look very different from the poison sumac we ourselves know; but it is really so different that it has been cultivated on a great scale for many centuries.

In fact, the Chinese have probably known how to use the plant for some three thousand

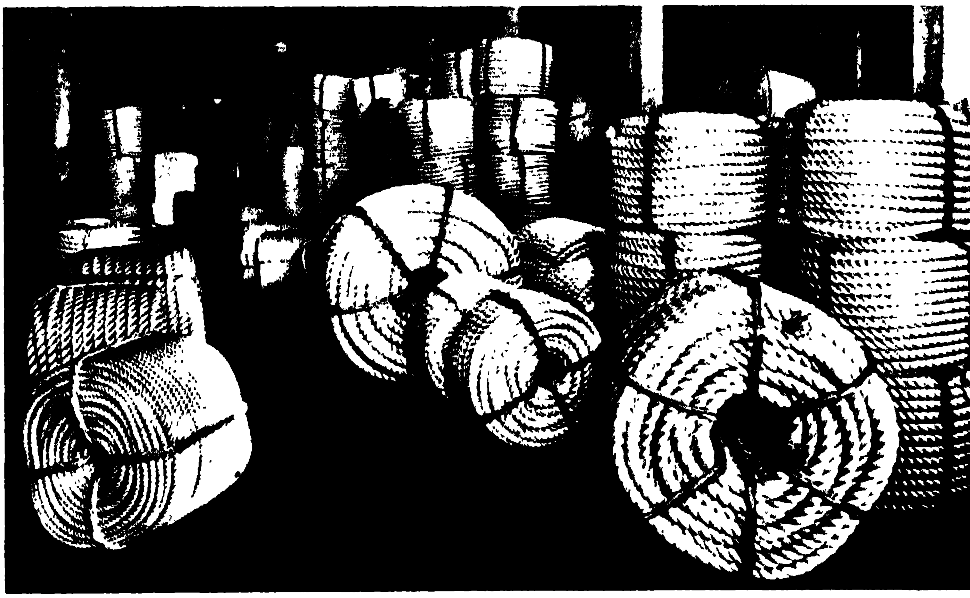


Photo by Whitlock Cordage Co

All this rope is made of esparto grass. We make rope of a good many different vegetable fibers, and we make it of twisted metal wires too; though when we say "rope" we still usually mean the fibrous kind. Hemp and flax used to be the fibers most used in ropes, but recently the most favored has been Manila fiber—named for the port in the Philippines from which most of it is shipped. Hemp is still largely used at sea.

years. Later, the Japanese learned the secret from them, and made lacquer (lăk'ẽr) work so popular abroad that it is often spoken of as "japanning." But there are still certain ways of working in lacquer which the Chinese understand best. And as for the rest of the world, it has dabbled in easy imitations and substitutes, but has never done much serious work in this difficult art.

Where Lacquer Comes From

Doubtless Western people are too impatient. Only the orientals would have the patience to do anything that takes so very long and requires such care and exact skill.

The beginning of the process is not difficult. To be sure, the juice or sap that is to become lacquer is slightly poisonous, but the workers soon become immune—that is, the poison does not affect them. To get the sap they select a tree about ten years old, and slit the bark. At first the sap looks like pale molasses, but after a while it turns black. Then they heat it slightly to drive off useless water, and put it up in air-tight bottles for future use.

Now begins the part which takes more patience than you would expect anybody in the world to have. The beauty of lacquer is that it is so shiny and so astonishingly hard—hard without being in the least brittle. Good lacquer is so hard that almost nothing can destroy it; bits of lacquer work found in wrecked vessels will be perfectly sound after lying for long years in the sea. But the only way this admirable hardness can be obtained is by putting on the lacquer varnish in many very thin layers and letting each dry slowly—in a *moist* place!

The Patient Art of Lacquering

So the craftsman covers his screen or chair or jewel box, usually made of wood, with a very thin layer of the lacquer juice. Then he sets it away in some damp place, possibly a cave, to dry as best it can. Then he takes it out again, scrapes and polishes it until you would think he was bent on rubbing all the lacquer off, puts on another coat, and puts it back in the drying place. This he will keep up day after day until he has put on perhaps twenty or thirty coats!

Even if this were all there was to it, our screen or chair or jewel box would by now be a handsome thing in its suit of gleaming black. But in fine lacquer work eighteen days or so of this sort of thing is only preparation for the real work in hand. For Chinese and Japanese craftsmen long ago found ways of coloring lacquer and of decorating it in red and yellow or inlaying it with silver or gold. In one famous and amazingly difficult Chinese process, the real work begins after all the layers of lacquer are on—just when you would expect the labor to be all over! This real work consists in cutting most delicately and accurately through the upper layers of lacquer so as to expose the colored layers beneath, which were planned, of course, so that they would fit into the final design.

The Juice That Gives Us Chewing Gum

Down in Central America there grows a tree called sapodilla (săp′ō-dĭl′ȧ), or, as the natives call it, "zapote." They know its fruit and like it, but American boys and girls have made them care most about its milky juice, which is called chicle. For chicle is nothing more nor less than raw chewing gum.

Yet though millions of pounds of chicle are brought every year to the United States from Guatemala, British Honduras, and Yucatan, there are not many chicle plantations. Why bother to raise the trees when they grow wild? So think the Indians, as they set out into the forest. When they come to a place where the sapodilla is plentiful—it is often growing in the same forest with mahogany trees—they make a camp. Then they work outward in every direction, gathering all the gum they can find.

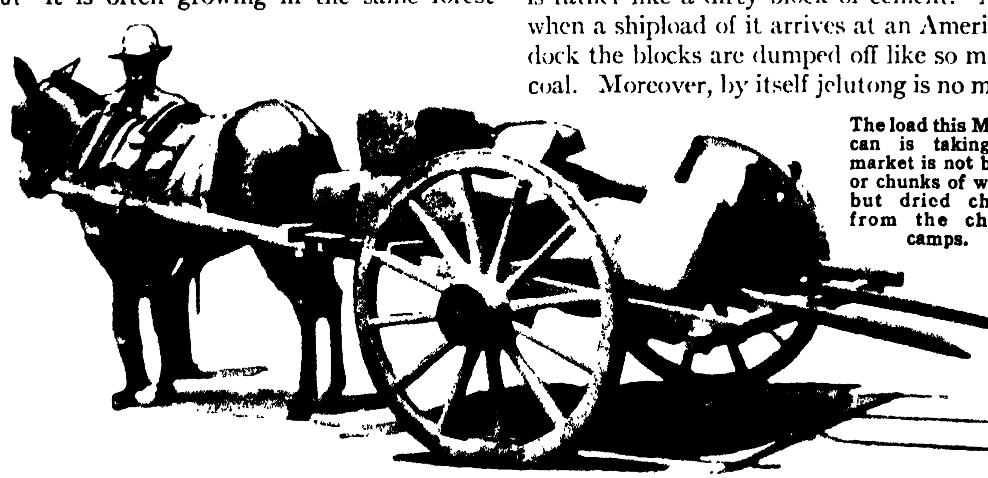
To get the sap, they make a V-shaped cut in the bark, setting a bucket underneath to catch the flow. If too many cuts are made, or if the trees are not given a few years' rest between cuttings, the trees will be bled to death. Because the Indians do not always remember this and kill a good many trees, the English in British Honduras have begun to experiment with chicle plantations. It is likely enough that some day there will be no more wild trees.

The Substitute for Chicle

As the gum flows from the bark, it looks a little like milk or cream. The Indians cook or smoke it, enough to make it harden; at this stage it looks rather like a crumbly piece of yellow dirt. In this form it can easily be shipped to the great chewing-gum factories.

But nowadays chewing gum is by no means made entirely of chicle. Several years ago the manufacturers began to worry about how much chicle costs and how long the supply was going to hold out. So they sent experts to Singapore. They chose Singapore because it is the center of the gutta-percha trade, and gutta-percha is not very different in some ways from chicle. The experts found a gum called jelutong which they thought would do.

Jelutong, when it is hardened, looks no more inviting than hardened chicle does—it is rather like a dirty block of cement. And when a shipload of it arrives at an American dock the blocks are dumped off like so much coal. Moreover, by itself jelutong is no more



The load this Mexican is taking to market is not brick or chunks of wood, but dried chicle from the chicle camps.

Photo by Brown Bros.

chewable than the eraser on your pencil. For that reason it is rather cheap. But mix it with a little chicle, and what a difference!

For even dry raw chicle, after your jaws have done their duty by it for a minute or so, tastes like a piece of unflavored chewing gum. Naturally that makes it more expensive than jelutong. So the chemists set to work to find a way to blend the two. Just how much they use of each is more or less of a secret. But recently in a single year 12,000,000 pounds of chicle and 16,000,000 pounds of jelutong came into the country.

Courtesy Wm Wrigley Jr Company

With the aid of his rope sling a workman is scoring the bark of a sapodilla tree deep in Central America. Chicle will flow down the V-slashes to the pouch.

Of course each gum has to be melted separately and thoroughly cleansed and strained. Then they are mixed, and to the mixture are added all sorts of flavors to suit different tastes. But no chocolate is added—no one has ever been able to mix that in gum, although sometimes they coat the piece of gum with a layer of it, to get a similar effect.

After the flavors have been added the gum is cooled and rolled into long bands about a foot wide. These are put between rollers coated with powdered sugar and are rolled thin. Sugar-coated knives cut the band into strips, and sugar-coated "fingers" pick up and pack the little slabs that are sold in the stores. Why all this sugar-coating? Because without it the mixture would stick to everything—very literally it would "gum up the works"!

What Is Cellophane?

Most of our food used to come in wooden boxes or wrapped in paper—or not wrapped at all. But now it comes to us in pasteboard cartons or in transparent cellophane (sĕl′ō-fān). These are much cheaper wrappings, and so they are used more—and as a result we get cleaner food.

The new wrappings are made of cellulose (sĕl′ū-lōs)—mostly of cellulose that we used to throw away. Cellulose, as you know if you have read the other stories about plants, is found in all plant tissue, particularly in the walls of plant cells. From it paper and artificial silk are made, and now this new industry has grown up to use the cellulose that once went to waste.

The waste, or "bagasse" (bȧ′găs′), from sugar and sisal mills, ground-up cornstalks, straw—any left-over material with cellulose in it—can now be put to use. The mass is put into a bath of caustic soda or lime. This dissolves out the perishable green material found in plant tissue and leaves behind nothing but pulp, which is nearly pure cellulose.

We use a fiber pulp like this for making paper—about which you may read elsewhere—but often the pulp is too coarse for that. Then it is turned into cartons or corrugated (kŏr′ŏŏ-gāt) paper—the springy, ridged paper or cardboard we use so much for packing fragile things.

While the pulpy mass is still hot and almost liquid, we treat it with rosin or glue, which gives it stiffness and the familiar brown color. Then we roll and press it into sheets, from which all sorts of containers can be made. It is not real cardboard; real cardboard consists of layers of ordinary glazed paper pressed together. But this coarse, stiff, papery substance has replaced cardboard, very largely, because it is so much cheaper. And for smaller packages, like boxes of breakfast cereal or soda crackers, it has replaced wooden boxes almost altogether.

Courtesy U. S Northern Regional Research Laboratory

A worker in a United States government laboratory pours chopped cornstalks into a cooker--the first step in turning them into plastics. Once a nuisance, the cornstalk has taken its place among other products of the forest and field as a source of the cellulose needed in the manufacture of a great variety of useful substances. In this way the factory has become an important customer for a good many of the farmer's products.

As for the shiny transparent cellophane in which we now wrap everything from doughnuts to baby dolls, it is made of a cellulose solution much like that used in making rayon, or artificial silk. Very similar cellulose solutions can be rolled out and hardened into photographic film or "movie" film, or mixed with other things to make the hard, shiny lacquer on automobiles, or the waterproof finish of airplane wings.

We even make "artificial wood" out of cellulose pulp—but that is not very strange, since the pulp was made out of wood in the first place. It sounds rather silly to take poplar or spruce or fir wood, grind it up into pulp, and then make "artificial" wood out of it. But it really is not so silly as it sounds, for the beaverboard and compoboard that result can be stiffened by the addition of chemicals and pressed under enormous weights till they are stronger than the soft woods of which they are made. Besides, not a particle of the wood is wasted in making them, whereas in all lumbering operations there is a good deal of waste.

So now we use millions of square yards of these compoboards—that is to say, composition, or "made-up," boards—in many different ways. We use them for partitions, for the backs of furniture, for lining material on walls or ceiling. Some are fireproofed, others are used to deaden sound, and others to keep an even temperature in a room. For they can be made so dense in structure that it is hard for heat or sound to come through them.

Indeed, if we add up all the uses of cellulose we shall agree with those who say that this is an Age of Cellulose as truly as it is an Age of Steel. Plants, which are made up so largely of cellulose, give us nearly all our food—either by feeding us or by feeding the animals we eat. They give us the clothing we wear and the paper we read from and the lumber to build our houses. And cellulose proper gives us our explosives and films and wrapping materials and lacquers and celluloid and the material for making things water-tight or fireproof. Even the coal we warm ourselves by is cellulose produced millions of years ago. Great indeed is the debt we owe to the trees and grasses!

The STORY *of* CORK

Reading Unit No. 6

WOOD THAT IS HALF AIR

Note: For basic information not found on this page, consult the general Index, Vol. 15.

For statistical and current facts, consult the Richards Year Book Index.

Interesting Facts Explained

Why cork floats, 9–296
Why cork keeps dry, 9–296
Cork in shoes, 9–296
Cork trees, 9–296
Harvesting cork, 9–296-97
Curing cork, 9–297
Cork floors, 9–297
The uses of cork, 9–297

Things to Think About

Why must a cork tree be fifty years old before it can produce cork of a fine grade?
Why does a cork tree continue to grow after the cork bark is removed?
Why must cork be boiled before it is usable?
Why is cork used in the walls of some public buildings?
Is rubber a satisfactory substitute for cork?

Picture Hunt

How is cork obtained? 9–297
What are the little marks found on cork? 9–296

Related Material

Which materials do not carry sound well? 1–445-46
How is cork used in refrigeration? 1–408-10, 10–515-19
How is cork used in the manufacture of shoes? 9–56, 60-61
How is cork used in fishing? 9–363
How are fishing nets kept from sinking? 9–361, 367
How is cork used to help preserve food in a cold-storage plant? 10–517-18
How is oil kept in the automobile? 10–288
How is linoleum made? 9–312

Practical Applications

How is cork used for sound proofing? 9–297
How is heat kept out of refrigerators? 9–297

Leisure-time Activities

PROJECT NO. 1: Make a cork float for a fishing line.
PROJECT NO. 2: Make a model float by fastening corks together.

Summary Statement

Cork, obtained from the bark of certain trees, is useful because of the many air cells which it contains.

Two thousand years ago the poet Horace could write in an ode about removing the cork from a jug; Plutarch tells of a messenger who swam flooded rivers with the help of cork. And to-day we have thought of many other uses for cork, from stopping medicine bottles to lining cold-storage plants.

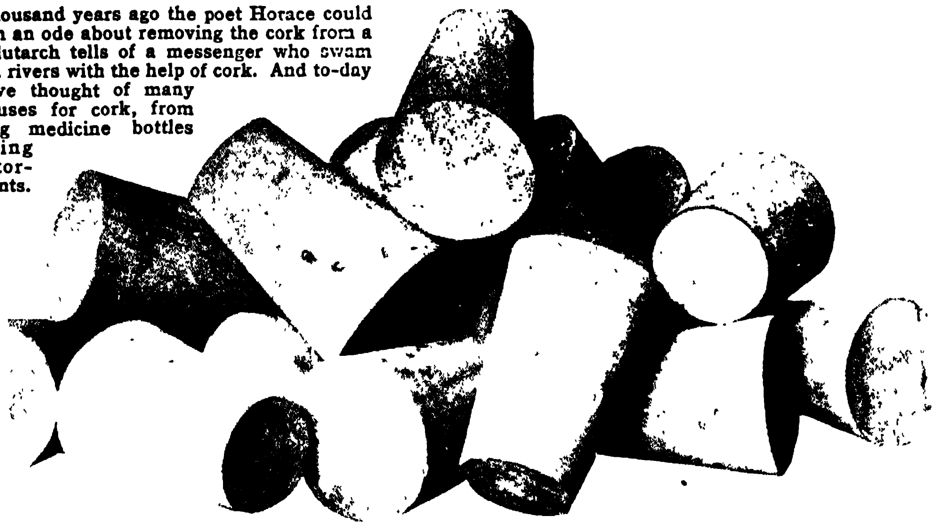


Photo by Armstrong Cork Co

WOOD THAT IS HALF AIR

That Is What Cork Is; and that Is Why It Will Do So Many Things That Nothing Else Can Do So Well

CORK is a very peculiar kind of wood. In the first place, it is more than half air. For any bit of cork is made up of a vast number of tiny cells, all clinging together and all filled with air. That is what makes it so light that it will float on the water almost like an air bubble; and that is why we put it into things like floats and life preservers.

In the second place, the air in it is what makes it so spongy, or so easy to compress and so quick to regain its former shape when we remove the pressure. For that reason we can wedge it into holes and cracks that need to be stopped up tight. But though it may be spongy in this way, it will never soak up water like a sponge; porous and airy as it is, it will never let through any water or any air. We cannot get it wet, like other kinds of wood, except on the outside. And therefore we use it in stoppers for bottles, in soles for shoes, and in other places where we do not want air or water to get through.

Cork is simply an outer bark that grows on two kinds of oak tree found in parts of Portugal, Spain, and France, and along the northern coast of Africa. The trees are evergreens, and they drop acorns that fatten vast droves of hogs. They may grow as high as fifty feet and be ten or twelve feet around, or even bigger; and with proper care they may keep yielding cork for as long as two hundred years. For the peculiar thing about these oaks is that they grow a thick outer shell all around their true bark. It is that shell which gives us the cork we use.

Every so often we can strip the tree of this outer shell. If we are careful not to injure the true bark we do not hurt the tree—though unless we are careful we may prevent the tree from growing any more cork, or may even kill it. For that reason we must not cut away the cork until the tree is fifteen or twenty years old, and then we must cut it only every eight or ten years thereafter; and always we must take pains never to cut into the bark while we are peeling off the cork. Wherever there are cork trees, there are laws to see that the trees are treated right by those who carve off the cork.

The first cork that we get from a tree, when it is about twenty years old, is always

coarse and rough in quality, and fit only for cheaper uses. The second, some ten years later, is better stuff, but still unfit for the finer purposes of cork. At each stripping after this the cork gets finer and finer, and when the tree is about fifty years old it is yielding cork of the kind that we use in stoppers for bottles. The very finest cork comes in small quantities from the branches of the trees in some of the lands where the law allows the stripping of these branches.

To get the cork the workers go into the forests in midsummer. First they cut a ring through the outer shell of the tree at the base, and another higher up, usually just below the point where the branches begin. Then they make two or more slits through the cork down the sides of the tree from the top ring to the bottom one, and prize off the cork in great slices. This leaves the trunk of the tree bare to its true bark, and ready to start growing a new shell of cork which will be cut away in eight or ten years more.

After the cork has been piled up for a few days to dry, it is put into great vats over a fire and boiled. The boiling takes out the tannic acid and also loosens the outer layer of the cork, which needs to be scraped off. Then the cork is flattened out under pressure and packed into bales for shipping to the factories where it is to be made into all the objects we may want it for. The factory may be a long way off; much of the cork crosses the ocean to America, where there are mills for turning it into many things.

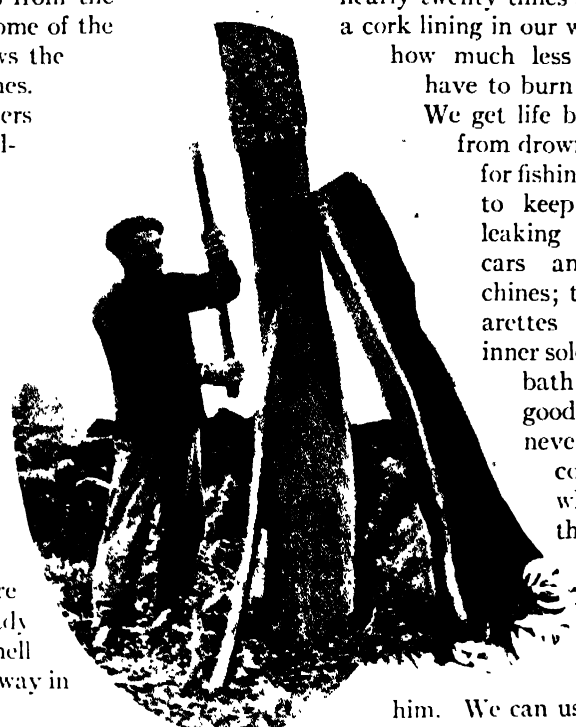


Photo 1

It takes a skillful hand to strip off the outer bark from the cork oaks without injuring the true bark beneath. And there are laws to say just how high above the ground the trees may be stripped.

Things We Make from Cork

And out of these factories we get hundreds of things that can be made better with cork than with anything else. We get stoppers for bottles. We get flooring in the shape of linoleum and kindred products, roofing of a similar kind, and cork boards to keep our houses warm and our refrigerators cold. For heat or cold will pass through ordinary wood over three times as fast as through cork, and through brick it will go nearly twenty times as fast; so with a cork lining in our walls we can see how much less coal we shall have to burn to keep warm. We get life belts to keep us from drowning, and floats for fishing lines; washers to keep the oil from leaking in our motor cars and other machines; tips for our cigarettes and our pens; inner soles for our shoes; bath mats that feel good to the feet and never get soggy; and cork balls with which we can throw wonderful curves on the beach and never hurt anybody even if we hit him. We can use it to line our rooms and our cold-storage plants, our engines and our hot or cold pipes, in order to keep the heat or the cold from escaping. Because it is so springy we can put it in many parts of our automobiles and other machines to absorb the noises and the shocks; and because it absorbs sounds in this way we can use it to line the walls and ceilings of our theaters and public halls, in order to deaden all bothersome echoes and to let us hear distinctly what the people on the stage or platform are saying. These are only a few of the uses, for work and for play, to which we can put this strange material. There are many other uses. How many more can you think of?

Reading Unit No. 7

"ALL THE PERFUMES OF ARABIA"

Note: For basic information not found on this page, consult the general Index, Vol. 15.

For statistical and current facts, consult the Richards Year Book Index.

Interesting Facts Explained

How long has perfume been in use? 9–299
The original purpose of perfume, 9–299
Perfume from flowers, 9–300
Artificial perfumes, 9–300
The rose of Damascus, 9–300-1
Absorbing the odor of flowers, 9–301
Perfumes from trees, 9–302
Musk and ambergris, 9–302

Things to Think About

What gives a flower its fragrance?
How may the fragrance be removed from flower petals?
Why is it necessary to add other things to the essence of perfume?
How are cheap perfumes made?

Picture Hunt

How are roses gathered for perfume? 9–301
How are orange blossoms gathered for perfume? 9–300

Related Material

Why is perfume making an important Bulgarian industry? 6–362-63
How is almond oil used in perfume? 9–312
How is the civet used to provide perfume? 4–296
How is oil of cloves produced? 9–209
What conditions affect the blossoming of flowers? 2–221-24
Why are insects attracted to flowers? 2–110, 103
Why is Japan called the Flowery Kingdom? 5–339, 345, 350
What is the source of synthetic perfumes? 9–307

Practical Applications

How are perfumes fixed to keep their essence? 9–302
How are the essential oils of flowers used to improve synthetic odors? 9–302

Leisure-time Activities

PROJECT NO. 1: Extract some attar of roses by the use of steam, 9–301.

PROJECT NO. 2: Collect the perfume of some flower by absorption with fat, 9–301.

Summary Statement

Perfumes are made from oils taken from flowers and other plants. The material is then fixed with the aid of certain animal materials and diluted.

Courtesy [illegible] Brothers, Inc.

A "perfume grower" walks through his fields of lavender in Southern France. Soon harvesters will gather the blossoming stalks, and the aromatic oil will be distilled and used in making perfumes.

"ALL *the* PERFUMES *of* ARABIA"

Here Are Some of the Secrets by Which the Makers of Perfume Steal the Odors from the Flowers

WHEN the Wise Men came from the East to visit the infant Jesus they brought with them precious gifts of "gold, and frankincense, and myrrh," and laid them at His feet. What were those two strange substances which, with fine gold, were worthy to be carried so far and to be presented with such lowly reverence? They must have been among the most precious treasures of the luxurious East.

The "frankincense and myrrh" were costly perfumes, valued by men as far back as we can trace the history of our race. They were burned before the gods to whom people knelt in ancient Egypt; Nineveh, Babylon, and Tyre all knew their fragrance; the temples of Persia and India and China were wreathed with their delicate smoke; and from the time of Moses they had served in the worship of the great Jehovah.

At first they probably were of use in covering the unpleasant odor of burnt offerings, but soon they came to be valued for their own sake. To-day, when we have modern sanitary appliances, we do not need to fill our nostrils with pleasant odors to make life bearable; and when we fumigate we use certain more deadly substances than our forefathers used. But this old and beautiful symbol of purification is still burned in many churches all over the world.

You may see, then, that perfumes have always been dear to our race, and that men have always been willing to pay a good price for them. Things are no different in that way to-day. The oil from rose leaves may cost as much as three hundred dollars a pound, and the essence of certain other flowers is even more expensive. Every corner of the world is ransacked to provide the tiny droplet that perfumes milady's handkerchief, and thousands of people spend their lives in raising the flowers to make it, or in extracting from them the fragrance that we

Courtesy Fritzsche Brothers Inc

For a very long time the Bulgarians have been among the world's greatest producers of rose oil for perfumes. Perhaps because their industry is so old, they are suspicious of modern methods. The distillers still put their rose petals in the vats that you see under the shelter of the roof, and feed by hand the wood fires kept burning underneath. But the attar they produce is as precious as if it were made in the most modern still by the most scientific methods. The wood piled in the foreground will be thrust through the oven door under each vat.

buy—greatly diluted—in a little bottle at the store.

The best perfumes used to-day are all made from flowers; and to capture and hold a blossom's delicate fragrance is one of the most difficult problems in modern industry. It is easy enough to combine certain chemicals and get a scent that will imitate the original flower odor fairly faithfully. The cheap perfumes are nearly all of them made in that way. Chemists analyzed the substances that produced the fragrance in the original flower, and then put them together in the laboratory. Often the result is quite natural, if you take a whiff that is hasty enough. But there is something about these man-made perfumes that always marks them. The flower still has some secret that the chemists have never learned.

Where Flowers Get Their Scent

Nearly all flowers owe their fragrance to an oil that is found in very tiny drops in their petals. There is so little of this in any single flower that it sometimes takes 250 pounds of the blossoms to make a single ounce of the essence—and the business of extraction is in itself very difficult and costly. But these essences are the very life of all good perfumes, and if we know how they are made, we shall understand the first and most important stage in the manufacture of perfume.

The Rose of Damascus

In Asia Minor there grows a wild rose that has always been called the damask rose, after the city of Damascus, near which it grows. Its large pink flowers have an exquisite fragrance, though they are not superior to many other roses in this respect; their extensive use in the making of perfume comes from quite another cause.

The great problem in all perfume making is to take the fragrant oil out of the petals without destroying its quality. All sorts of

methods have been tried, but to-day the oil is largely extracted by steam; and the fragrance of the damask rose survives this process better than that of any other rose.

All through the extraction the greatest care must be used. The oil evaporates easily, and so loses its fragrance. To prevent evaporation is one of the chief problems. All the roses used are grown for the purpose—in India, Asia Minor, Bulgaria, and France. When they are ready to give up their fragrance, they are gathered and put in retorts into which live steam is driven under pressure. When it passes out of the retort it carries with it, in the finest sort of suspension, the delicate particles of the oil that has given the rose its fragrance.

Then the steam is condensed, and on the surface of the water floats a tiny film of rose oil, which from now on is known as "attar of roses," a most valuable article of commerce. It is skimmed off the liquid, and used to scent hundreds of bottles of rose perfume. A single pound of it may hold the fragrance of two acres of roses. A drop of it will scent a gallon of toilet water.

Capturing Fragrance with Grease

Many other flower essences are made in the same way as attar of roses; but certain very choice one, like those of jasmine and tuberose, would be ruined by the steam process. For these there is a different method.

Everyone who has an ice box knows how easy it is to spoil butter by setting it too close to cabbage or onion. Butter absorbs odors very quickly; and perfume makers have learned how to make use of this ability of nearly all fats to take up odors and hold them. When certain very delicate flower essences are to be extracted, the manufacturer smears thousands of sheets of glass on both sides with the fat from uncured bacon, or with an especially prepared fat taken from pork and beef. The smeared plates are then stacked in frames, and between them fresh petals of jasmine or tuberose are spread. In a few hours the fat has absorbed the odor, and then a fresh lot of petals is put in. This process is repeated until the fat has taken up all the fragrance it can carry.

The odor-laden fats are then scraped off the plates and chemically treated to remove the perfume. The result is a pure essence which, in the case of jasmine and tuberose, is the most costly of all flower essences.

There are still other methods of extraction. The fragrant oils may be pressed out of certain flowers and leaves, just as cider is pressed out of apples. The process depends on the nature of the oil to be extracted.

Though flowers are the chief source of perfume essences, other parts of plants are often found to contain valuable fragrances. Of course it is from the flowers that we get the essences of carnation, hyacinth, rose, heliotrope, jasmine, tuberose, orange blossom, mignonette, violet, and jonquil. But for lavender, rosemary, peppermint, and sometimes for violet too, we use both flowers and leaves. Rose geranium, cinnamon, and patchouli (pá-chōō'lĭ) are taken from leaves and stems, and sassafras, calamus (kăl'ā-mŭs), and vetiver (vĕt'ĭ-vẽr) come from roots and underground rootlike stems. The fruits, and especially the skins, of orange, lemon, lime, and bergamot (bûr'gȧ-mŏt) give

"Which compound has the truer, more natural scent?" asks this laboratory worker of his nose. So delicate is his sense of smell that the testing of the scent of flower essences has become his profession. We may be sure that he never smokes, eats garlic or onions, or does anything else that might impair this valuable faculty. Upon it depends the fine quality of perfumes that may bring the manufacturer a fabulous price.

Courtesy Fritzsche Brothers, Inc.

us delightful essences; as do the seeds of the bitter almond, anise, and nutmeg. And it is from the gum or resin of certain trees that we get frankincense, balsam of Peru, storax, and myrrh.

All of the above essences are exceedingly expensive. No matter how much you may pay for the finished perfume, a bottle of it will contain only a very tiny dose of the essence—and perhaps none at all if the scent is artificially made, or what we call "synthetic" (sĭn-thĕt'ĭk). A real essence is usually so strong that it must be diluted to seem natural. The scent of pure attar of roses is unbearable, and so are a number of other flower essences.

Now of course the question at once arises as to what the essences shall be diluted with. This is a matter of great importance, for not only must their overpowering strength be reduced, but they must be combined, if possible, not only with something that is certain not to spoil their delicate fragrance, but also with a substance from which they will not evaporate too easily. For perfumes of moderate price, artificial odors are used with just a drop of the true essence added. These make very good perfumes, but they have never satisfied the person who wants the true flower scent captured and held for months or years.

To make the finest of all perfumes, strange—and very expensive—methods of manufacture have been discovered. To slow down the rate at which the essences evaporate, they are combined with various gums, resins, and balsams, all of which are especially prepared so that they may have no odor of their own to interfere with the natural flower fragrance. Sometimes musk is added. This is a very strong animal product that is obtained from a little sac found in the male musk deer, which lives in the Himalayas. The deer is killed and his musk is carried by caravan to Shanghai, there to be loaded on boats bound for Europe.

Probably the most costly perfumes in the world are those to which a strange substance called "ambergris" (ăm'bẽr-grēs) has been added. This extraordinary material is manufactured only in the intestines of a sick whale. Naturally, the finding of sick whales is not very easy; so even though a chunk of ambergris is sometimes found floating in the sea, supplies of it come on the market pretty rarely. That is why one 248-pound piece of the curious waxlike substance was sold to a French perfumer for $60,000. The great value of ambergris lies in its power as a "fixative"; that is, it will carry the odor of any flower essence almost indefinitely, and will release the fragrance at just the right rate.

The final blending of flower essences with their carriers is not a science but an art. Most good perfumers have many secret formulas. In France some of these have been handed down from father to son for generations. To-day the fields around the cities of Nice (nēs) and Cannes (kăn) and Grasse (gras), in Southern France, the center of the world's perfume industry, are odorous with the fragrance of countless blossoms from which will be made perfumes famous all over the world. For the French, more than any other people, know how to capture the haunting fragrance of a flower, and to imprison it in a bottle of delicate perfume.

Reading Unit
No. 8

TURKEY RED AND PEACOCK BLUE

Note: For basic information not found on this page, consult the general Index, Vol. 15.

For statistical and current facts, consult the Richards Year Book Index.

Interesting Facts Explained

Vegetable dyes, 9–304
A dye that comes from an insect, 9–305
Dye from snails, 9–305
Indigo, 9–305
Black dye, 9–305-6
Synthetic dyes, 9–306
Ink, 9–307
Printer's ink, 9–307

Things to Think About

Why are inks mainly vegetable dyes?
Why are vegetable dyes better than other dyes?
Why are fixing chemicals used with dyes?
Why is printer's ink really a varnish?
What would happen to the world if suddenly all our dyes should fail?

Picture Hunt

What is the source of the raw materials used in making ink? 9–304

Related Material

How is color used in tapestries? 12–141
How do oriental rugs get their colors? 12–157
What is the difference between cotton and wool clothing? 14–550
How do we get ink from the octopus? 3–168, 171
What is invisible ink? 14–243
Why do flowers attract insects? 2–163
What is the effect of sunlight upon colored materials? 10–446

Practical Applications

How are dyes made to last in cloth? 9–306
How is the color of butter and cheese made more attractive? 9–305

Summary Statement

Plants provide the colors used to make cloth and other materials more interesting and beautiful.

Photo by Cart

There is no telling what unexpected things men will use for their purposes—purposes often quite different from those of Nature. For instance, consider Aleppo galls, the round "oak apples" pictured above. An insect comes along and deposits an egg in the tissue of the wood, as is shown in the upper part of our picture. The tree reacts against this unwelcome guest by growing a lump of special tissue around the egg and later around the larva that hatches from it. Then men gather these queer growths—to make ink!

TURKEY RED *and* PEACOCK BLUE

Where We Get Our Beautiful Dyes and Lasting Inks, and How the Chemist Has Learned to Make Them for Us

HAVE you ever tried to imagine what the world would be like without color? Suppose that the country landscapes, the rolling seas, and the towns were all one dull gray—no green leaves or bright flowers or blue waves or red brick house fronts. And suppose that all the people were dressed in dingy gray—no gay spring hats, no flaming sweaters, no rainbow-shifting of colored gowns at concert or party. How much of the beauty would be gone out of such a world!

As long ago as we have any record, people already loved color and wished to deck themselves and their homes in it. They wanted to copy the hues of the flowers and the sunset on their bodies, in their clothes, in the fabrics they used for other purposes. So they invented dyes.

Until very recently all the dyes were made out of things found ready at hand in nature; they usually were made from some sort of plant life, and so we speak of such dyes as vegetable dyes. The most lasting and beautiful dyes in the world came and still come from the juices of certain plants. Some of these old vegetable dyes, made perhaps six thousand years ago in ancient Egypt, are to-day as fresh and vivid as ever. None of the new chemical dyes will last that long.

Look carefully at the sweater you bought year before last—it will be very unusual if it has not already begun to fade.

Many of the American Indians were very clever makers of dyes. Along the Amazon there are Indians who stain their faces a brilliant red with "urucu" (ōō'rōō-kōō'). They get this dye from the red fleshy covering of the seed of the annatto (ȧ-nä'tō) tree. This annatto dye is a brilliant red, very fiery, and it is one of the most lasting reds known. Some of it, found in Inca temples in Peru, must be at least three thousand years old.

A Dye That Tints Our Cheese and Butter

But annatto is not always red. When you mix it with other substances it becomes light yellow. And recently chemists have discovered that it is the very best coloring matter for butter and cheese, both of which would be too pale to suit the public without it. No other yellow dye is so tasteless and so completely safe as this, and so it now goes into our dairy products in enormous quantities. While a handful of Indians still use it as a red dye, the tree is commercially grown in the Tropics for the butter and cheese makers of the Temperate Zone.

Another dye which comes from the warmer regions of America is cochineal (kŏch'ĭ-nēl). This is not really a vegetable dye at all, for it comes from the dried bodies of the little cochineal bugs which feed on a certain cactus, called nopal (nō'päl), common in tropical America. This nopal, which is a second cousin to the prickly pear, has fleshy joints much prized by the little bugs as food. Long before Columbus landed in the New World the Mexicans were cultivating the nopal so that the female cochineal bug should never be without food.

Bugs That Make Red Dye

The dye made from the cochineal bug is a bright and lasting red. It takes seventy thousand bugs to make a pound of it; so the growing of nopal grew to be quite a business. And cochineal is still one of the best of all red dyes. The plant and the bug have both been introduced into Spain, Africa, and Peru on a large scale to supply the trade. But for many purposes cheaper chemical dyes have now taken the place of cochineal.

A very famous ancient dye was also made from animal rather than vegetable life. This is the "royal," or "Tyrian," purple, for which ancient Tyre was famed. It was made from the crushed shells of a certain sea snail. When the ancient Hebrews spoke of "purple and fine linen" they referred to this costly and beautiful dye.

But perhaps the most famous dye in the world is indigo. Certainly it is the most lasting and perfect blue dye ever known. It comes from the juice found in the leafy shoots of the indigo plant of India; and there are people who think that India got her very name from it. Whether this last is true or not, the people of India have known all about indigo for something like five thousand years.

Whoever made the discovery must have been a clever man, for oddly enough, the juice that makes this magnificent blue is in its natural state quite colorless. To get the dye, you must first soak the leaves in water to get out the juice. Then you must add an enzyme (ĕn'zīm), some agent that works upon the juice and separates it into two elements. One of these new elements is just a kind of sugary liquid, but the other is indigo blue. This precious indigo blue is at first only a pasty mass, but when it is dried and pressed into cakes you have one of the most valuable dyes in existence.

The King of Dyes

There are to-day many chemical blues, but none so good as indigo, especially for ink. So this age-old Indian coloring substance is still called "king of dyestuffs."

Color experts tell us that black is not really a color at all, but the complete absence of all color. But nevertheless it looks like a color to most of us—and a very handsome and useful color too. Not only do we use it a good deal alone, but we mix it with other colors to make different shades. It is interesting that the most ancient dye makers got their black in very much the way that modern chemists do. That is to say, they burned something in order to obtain the sooty deposit left by the smoke. This

deposit we call lampblack because it gathers in such annoying abundance on the chimney of an old-fashioned kerosene lamp.

The Egyptians and Chinese used to burn a hardwood stick grown especially for this purpose, and then scrape up the sooty deposit from the smoke. Although the ancient dye makers did not know it, what they thus scraped up was almost pure carbon, absolutely indestructible, and of course pure black. To-day the chemists, who know all about carbon, burn rosin or fuel oil in especially prepared chambers from which nearly all the air has been shut out. Then they too scrape up the soot from the dense smoke, but they do it by machinery, and they know very well that they are getting pure carbon. This lampblack dye is still the commercial source of a large number of black dyes.

The Secret of the Logwood Tree

But lampblack will not do for all purposes: it is not properly absorbed by cotton and wool, of which so many of our fabrics are made. So dyers for a long time kept on the lookout for a black that would fill this lack. They finally found it in the heartwood of a Central American tree called logwood.

The logwood had been as secret about its precious dye as had the indigo plant. It was merely a medium-sized tree growing on the hot plains near Campeche (käm-pā'chā), in Mexico, where it was first discovered. The wood is reddish, like that of many other trees. And the juice is colorless. The secret was that this colorless juice would yield a violet-purple substance known as "haematein" (hē'mȧ-tē'ĭn) from which the black dye can be extracted.

The chemists soon found that this dye is not a permanent black of itself, but requires the help of what we call a "mordant." A mordant is a "fixer." That is, a mordant added to a perishable dye makes it a permanent one. The mordant of logwood is a salt of iron. When this is added, logwood becomes one of the very best black dyes for wool and cotton and also for the making of some kinds of ink.

Many other vegetable dyes need a mordant. The commonest of these fixers are salts of iron, tin, copper, and other metals, and the tannic acid found in some tanbarks or that found in Aleppo galls, of which we shall hear more in a moment, when we speak of ink.

From all this it is quite clear that the vegetable dyes are still very important today. But the cheaper dyestuffs nowadays are largely "synthetic" (sĭn-thĕt'ĭk); they are artificial products, "built up"—that is what the word means—by chemists from various elements.

This has come about, like so many similar things, because we moderns are always in a hurry and looking for labor-saving devices, and because we are always wanting to make enormous quantities of things at once, quickly and cheaply. In olden days no one protested at the trouble it took to get yellow from the saffron crocus or the gamboge tree of Asia. And if you had to get fustic, to make yellow, from Jamaica; brazilwood, to make red, from South America, woad, to make blue, from Europe; and madder, to make turkey red, from Turkey, it did not matter. You got them if you could afford it; if not, you went without. But with the dawn of our own Machine Age, dye makers began to be impatient of these difficult processes and expensive journeys. They wanted to make tons of material and thousands of gallons of a single dye to be used at one time, and they wanted to be able to sell it cheap. They wanted, in short, to be free of vegetable dyes altogether.

So they set to work to invent new chemical dyes. And though the finest and most lasting dyes are still of the older vegetable sort, the chemists have certainly achieved wonders. The industry was developed particularly in Germany, which for a long time produced nearly half of the 160,000,000 tons of chemical dyes that were made yearly. The German dyes were by far the best. One of the first commercial effects of World War I—as many of us can well remember—was the shutting off from England and America of the dyestuffs we had been in the habit of buying from Germany. Once, before the United States entered the war, a German submarine made an exciting dash through the blockade and landed a cargo of dyes on our shores. After the war many nations,

but especially the United States, France, and England, built up flourishing industries in the manufacture of chemical dyes.

Of course all this has meant a tremendous amount of careful research. In this too Germany once excelled, but England, France, and the United States have now surpassed her. These chemical research workers will never be satisfied until they produce synthetic dyes as fine and lasting as indigo and the other ancient vegetable dyes. If they ever succeed in doing that, perhaps the making of vegetable dyes will pass into history.

What Are Aniline Dyes?

The synthetic dyes are sometimes called "aniline" (ăn'ĭ-lĭn) dyes, though that is not the most accurate name for them. It comes from one of the things that go to make up coal tar, and the term is used because so much aniline goes to the making of chemical dyes. But many other constituents of coal tar are used, also. This coal tar is a black substance full of carbon which is the residue left after the manufacture of ordinary illuminating gas. Besides dyes, the chemists have made drugs, flavoring extracts, and napthalene from coal tar, and it has now become a very important substance in the industrial world. Making dyes out of it is an extremely complicated business, and it has taken the research workers forty years to work it out.

A very special kind of dye is ink. It has to have a good many qualities that ordinary dyes do not need. It must flow easily, it must not smudge when it is dry, it ought to be absorbed by the paper, and it should dry without taking on a shiny gloss like varnish. It is far from easy to get all these qualities, and so far the chemists have not been able to make many lasting inks by the synthetic process—and no good synthetic black ink at all.

Even the ordinary vegetable blacks will not do. Lampblack clogs the pen. What ink makers do is to use a certain "gall," or malformation, that appears on oak trees. Such galls are called Aleppo galls because they grow on oak trees from the region around Aleppo, in Syria. They look like small nuts. Their value comes from the fact that they contain a very large amount of tannic acid, which can be drained out by crushing them.

The extract of Aleppo galls is at first nearly colorless, but after it has been exposed to air for a while it turns blackish or bluish black. Clever chemists know how to make it turn even blacker, and can make an ink that gets still blacker *after* it dries. This kind of ink lasts longer. Sometimes a solution of logwood is added in making special inks, and some indigo is put into blue-black inks. This last kind writes blue but turns black in a day or two.

But an ink must not only be the right color and be lasting—it must also flow freely. To keep some inks from settling and so getting gummy toward the bottom of the bottle, the makers add an extract of plant gums; it sounds odd to add gum to keep a thing from being gummy, but it seems to work. The ink makers use mostly gum arabic and gum senegal (sĕn'ē-gôl'), both of which are really gum resins. They are easily melted and help to hold in suspension those particles that might otherwise make the ink muddy.

Nearly all good writing inks are made in the ways we have been describing. Red inks have to have coloring matter added to them, usually cochineal. Green inks are tinted with green vitriol (vĭt'rĭ-ŏl). And of course blue inks are colored with indigo. The basis of most of them, whatever their color, is the extract of Aleppo galls.

Printer's ink has very different requirements from writing ink. It has to dry almost at once. So the ink makers make a kind of varnish out of linseed oil, rosin, and—of all things—soap. Mixed with the coloring matter this will stick to the type in just the right way; it will lie on the printed page sharp and clear, without blot or smudge, as ordinary writing ink certainly would never do.

So the story of dyes takes in many things in our world—from the delicate or brilliant shades of tapestries and dresses to the paper that brings us the latest news. Dyes are just another of those vastly important things which we usually do not bother to think about.

Reading Unit
No. 9

SURPRISING PRODUCTS FROM PLANTS

Note: For basic information not found on this page, consult the general Index, Vol. 15.

For statistical and current facts, consult the Richards Year Book Index.

Interesting Facts Explained

Gutta-percha, 9–309
Jute, 9–310
Condiments, 9–310
Mustard, 9–311
Turpentine, 9–311
Rosin, 9–313
Broom corn, 9–314
Amber and petrified trees, 9–313-14

Things to Think About

Why is gutta-percha used in place of rubber for electrical insulation?
Why is jute used for sacks, instead of cotton or other fibers?
Why are the products of the pine tree of especial importance?
How may wood turn into stone?
Do we prize amber more highly because of its interesting history?

Picture Hunt

How is the raw material for turpentine gathered? 9–309
How does broom corn grow? 9–313

Related Material

What materials besides gutta-percha are used for electrical insulation? 1–514-15
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Leisure-time Activities

PROJECT NO. 1: Gather some rosin from the bark of a pine tree, 9–313.

PROJECT NO. 2: Rub a piece of amber on silk, 9–314.

Summary Statement

Certain useful and necessary materials are derived from pine trees, parsley plant relatives, jute, and corn plants.

Photo by U. S. Forest Service

The United States produces the major part of the world's turpentine and rosin; it comes largely from the loblolly and swamp pines which grow in the Southeast. This picture shows workers gathering turpentine in the Florida National Forest. They load it into barrels in the woods and haul it off to the still.

SURPRISING PRODUCTS *from* PLANTS

You Will Here Find an Interesting Answer to Many a Question about Things You See Every Day

HAVE you ever tried to figure out what a golf ball is made of? It is not elastic and soft like rubber, yet clearly it is not wood. The odd substance of which it is made is called gutta-percha. It is the same material we use to wrap up the submarine cables which carry our messages back and forth far under the ocean.

Before the scientists discovered gutta-percha they were at their wits' end to know how to insulate submarine cables—that is, what to wrap them in, to keep the water out and the electricity in. They had thought rubber might do. But it turned out that rubber wrappings soon began to leak; then of course the cable would be "dead."

The solution of the problem came out of the Malay jungles—of all places! About seventy-five years ago a British surgeon at Singapore noticed the natives using a black, hard substance for sword hilts and axe handles. At first he thought it must be a new kind of wood, but he discovered that it was not wood at all. It was the hardened milky juice of what the natives call the "taban" or "gutta" tree. The queer fact that such hard, resistant things as axe handles could be made from the sap of a tree struck him as worth looking into. And sure enough, it was soon found that gutta-percha, as it came to be called, is one of the most remarkable gums in the world.

Its remarkable—and useful—quality lies in the fact that when it is cold it is extremely hard yet not brittle, but that when it is heated it can be pulled into threads, made into almost any sort of implement, or wound around cables to insulate them. Then when it cools again in its new shape it will be just as hard, just as nearly impossible to destroy, as it was before. Rubber will not act in this accommodating way, nor will other gums.

So now the Malay natives cut down the gutta trees in vast numbers and take out the milky sap, boil it down, and send it away. A related gum from Brazil, called "balata," is widely used also. The telephone instrument on your desk, many other electrical

appliances about the house or office or factory, many of the surgical instruments in the doctor's kit—all these may be made of gutta-percha. Gutta-percha was the answer to the problem of the electrical engineers who wanted to lay a deep-sea cable, for it is one of the most perfect and lasting of insulators. And who shall say how much is added to the joy of crying "Fore!" because the gutta-percha golf ball springs swiftly forward with so satisfying a "ping"?

Sugar bags and burlap, gunny sacks and coffee bags—these things we use by the hundreds of millions every year. The material that goes into them has to be cheap, far cheaper than linen or even cotton, because sacks and other things of this sort are meant to be used once and thrown away. So when people all over the world began buying sugar and coffee, the manufacturers had to look about to find cheap containers.

Photo by U. S. Dep... ment of Agricult...

This sturdy little plant, whose leaves are hoary green, is garden sage. There are several species of sage with brilliant flowers grown for show. Ordinary garden sage is slightly tonic, and "sage tea" is an old home remedy for ills. But mostly we use sage as a condiment—to flavor sausages or meat dressing or cheese.

Why Most of Our Jute Comes from India

They found the best material for their purpose in India, where the natives had been using it from as far back as men could remember. This material is called "jute," from a native name. Since it became so popular, people have tried to grow it in various other warm, moist climates, but most of it still comes from India—largely, perhaps, because the natives there are more willing to do the "retting," or preparation of jute, than anyone else is.

For this retting is not a pleasant job. Jute is a stout herb, and the fiber is in the stem of it. The process of retting consists in getting the fiber out. Sometimes the plants are allowed to dry for a time so that the leaves may be stripped off as a beginning. Sometimes the whole plant is dumped into the trench or pool where it is to be allowed—and encouraged—to rot. For that is the whole point of retting; the fleshy part of the stem must be rotted away to leave the fiber bare and clean.

This takes a good while, of course, and to hurry it up, the native laborers stand waist-deep in the foul, slimy water and thresh the stems about to clear away the fleshy part. The process usually takes about two weeks. So far, no chemical substitute for this dirty work has been found practicable.

The fiber is then spun into yarn from which are made the bags and burlap bagging. As you know, the material that results is coarse and harsh to the touch. Yet jute yarn can be bleached nearly white or dyed attractive colors, and is sometimes mixed with cotton or linen for various more dignified uses, such as the webbing in chair-bottoms or hangings for informal rooms.

The trouble with it is that it does not last very long. Unlike cotton or linen, jute fiber begins to weaken very quickly with age and in the end will nearly fall apart. But it lasts long enough to be used on a gigantic scale for the making of bags which can serve their brief purpose and then be thrown out as rubbish.

What Is a Condiment?

When you put mint sauce on lamb or mustard on roast beef, you do not do it to make them more nourishing. Neither would sage or horse-radish or coriander make very filling foods. But we like these things just the same—because they make our food taste better; they give it a sharper flavor. Long ago the French called such things "condiments" (kŏn′dĭ-mĕnt)—from a Latin word which means "to season."

Spices are seasoning too, of course, but the things we call condiments all come from simple herbs that grow in temperate climates such as those of Europe and the United

Photo by U. S. Forest Service

This is a turpentine still, or distilling plant, in Florida. The "stiller," or operator, is listening to the sound of the boiling turpentine, for every change in the sound it makes tells him of the progress of distillation. This process separates the oil from the cruder parts of the oleoresin, or crude turpentine.

States. Indeed, some of them come from well-known garden plants, or even from familiar weeds of the fields. So some people who live in the country still grow or gather their own condiments. But many more of us buy them all prepared for use. There are wide acres of commercial gardens where they are grown for sale.

Where Mustard Comes From

About the most familiar of all condiments is mustard—that old friend of ham sandwiches and "wieners." Did you know that the wild mustard which flaunts its gay yellow flowers from many a farmer's cherished hayfield is the same mustard which we buy put up in jars? That is, we buy the dark brown seeds it bears after they have been ground up to free them of the oil of mustard they contain.

Mustard is a relative of cabbage, and so is horse-radish, another popular condiment. Horse-radish grows wild all over Europe and Asia, but has been grown in gardens in America. It is the roots that we eat, not the seed. All that has to be done to them is to clean and grate them— and not put too much on our food lest we blister our tongues!

But condiments are oftener made from seeds like mustard than from roots like horse-radish. Coriander (kō'rĭ-ăn'dẽr), celery seed, and caraway all belong to the parsley family and come from European herbs related to ordinary celery. Every one of these savory seeds contains a strongly-scented oil, and it is for this that the cooks like them. It would be too hard on our stomachs to eat great quantities of these pungent oils, but a little of them gives food a flavor nothing else can give it.

Then there are the condiments which come from European herbs of the mint family—summer savory, sweet marjoram (mär'jō-răm), thyme (tīm), sage, and mint itself.

These too have fragrant oils. But in this family of herbs the oil is scattered through the leaves instead of being all in the seeds. And, except in mint proper, the oil keeps its flavor even when the leaf is dried. So we buy these condiments in dry powder made by cleaning and grinding up the leaves.

Most condiments are very simple to prepare. But there is nothing simple about curry powder. It is made of the powdered leaves of the curry tree and is mixed with over fifteen powdered spices and fragrant leaves! It is as hard to digest as it is to make; so one has to be careful about eating much of it. Yet in India, where it is made, and among many Europeans and Americans, its strange, pungent flavor is thought the best thing in the world to season eggs or rice.

It is astonishing to see for how many things we use oil made from plants. We have written special stories about some of the oils we eat—olive oil and cacao butter--and about one or two we take for medicine, like castor oil. And there is a special story about palms, too, which tells of the uses of palm oil. But there are many other vegetable oils, and they have many other uses. We use them to lubricate machinery—that is, make the parts slip easily over each other—to make soap, and above all to make varnishes and paints.

Some oils are valuable because they dry up in a special way. Perhaps the most important of these is linseed oil, used all over the world for mixing paints. It comes from the "linum," or flax plant, from which we also make linen; that is why it is named "linseed" oil. A good deal of it is grown and produced in the United States. We use linseed oil to make some kinds of soap, too, and—as you would guess from the name—to make linoleum. But by far its most important use is in the paint trade.

Photo by U. S. Department of Agriculture

Those of us who live where it is too cold to grow cotton will probably not recognize this pretty plant—for the pictures usually show immense fields of it like one blur of white. But here are the little white puffs that furnish our summer dresses and cover the oil-bearing seed.

Tung oil, or Chinese wood oil, dries with a hard, shiny surface. For centuries Chinese and Japanese painters have known this, and so have mixed tung oil with various colors to make enamels dry quickly and with a bright, hard finish.

Then, on the other hand, there are some oils which are valuable because they practically never dry at all. This kind of oil we sometimes mix with other things to make soap. Hempseed oil, which grows all through the North Temperate Zone, illipe (ĭl'ĭ-pē) oil, which comes from the East Indies, shea (shē) butter, which comes from Africa, and cottonseed oil, a large part of which comes from the United States—all these we put into different kinds of soap. Cottonseed oil goes to the making of salad oil, too. Rapeseed oil, which is produced in Europe and India, we use to oil machinery and sometimes to give light when it is burned. Almond oil is the aristocrat among vegetable oils, for we use it to make perfumery.

How You Can Find Resin

If you live where there are pine trees, perhaps you have sometimes noticed a little hard knob of dried gum on one of them, or

Photo by U S Department of Agriculture

Here is a field of broom corn, waving its tops in the wind as proudly as ordinary corn—and why should it not? This particular field is in Oklahoma; on the wide prairies there broom corn is a favored crop.

even discovered the gum before it has dried, oozing out from a wound in the bark. This strong-smelling, gummy sap is called resin (rĕz'ĭn)—you will observe that the word is spelled with an "e."

What Is Oleoresin?

Now certain kinds of pine trees, and a few other plants, have resin which is much more complicated—and much more useful—than ordinary resin. For a great many years men have been tapping such trees just as we tap trees for maple sirup, and taking out what is called oleoresin (ō'lē-ō-rĕz'ĭn). This is a strong-smelling, oily liquid. In its natural state we call it "crude turpentine."

Out of this oleoresin, or crude turpentine, we get all sorts of very different useful things. We get common turpentine, which is valuable in making varnish and in mixing with paints that are to dry with a dull finish instead of a glossy one. By separating all the impurities and keeping only the finest oil, we get also oil of turpentine, which is a valuable medicine.

Then there are the by-products, the most important of which are rosin and pitch. The word "rosin"—spelled with an "o"—is really only another form of resin, but it has come to have a very special meaning. It is the waxy substance with which we rub the bows of violins. It has a great many other uses too—it is put into soap, into special kinds of varnish, into certain cements, into paper, into shoemaker's wax. It even goes into some kinds of ointments and plasters.

When everything else that is usable has been taken out of oleoresin, what is left is pitch. And this is useful, too. It is a sort of vegetable tar, sticky and blackish-brown. Sea water has a very hard time passing through it, so ships' ropes are often soaked in it; and it is made into oakum to smear over the sides of wooden ships.

Gifts from the Pines

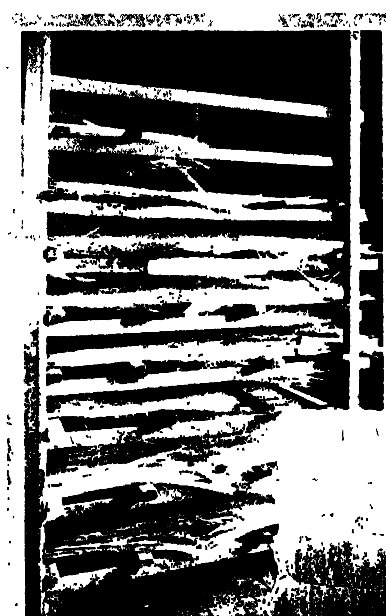
All these things, and others besides, are made by the action of chemicals on crude turpentine. The turpentine-bearing pines are frugal trees that waste nothing, and yet manage to be very generous in their gifts to us!

There is one kind of resin which has to be mined like coal or iron. This is amber, the clear, golden-brown substance we see so often in beads and the stems of fine pipes. Deep in the earth it has lain for thousands, perhaps millions, of years, and it comes to us like a voice from the unbelievably distant past.

Amber is really a fossil, just like the bones

of mammoths or the shells of sea creatures that lived millions of years ago. It was once soft, sticky gum on the bark of trees. Sometimes a bit of bark or a twig, or even a tiny insect, would stick in it and the gum would close over the little creature forever. Water cannot get into true resin, and so it does not rot; and whatever is inclosed in it does not rot, but is kept exactly as it was while uncounted ages roll by.

Finally the shores of the Baltic Sea, where most of our amber was formed, began to sink. The bits of resin were buried, with infinite slowness, under the earth or under the sea. There they hardened at last, and became amber. Sometimes it is washed up by the sea, and sometimes, especially during the last two centuries, we dig for it.



Above is a drying rack full of broom corn, and to the right a bale of broom corn all ready to be made up into brooms.

Photo by U S Department of Agriculture

If you rub a piece of amber, it will become charged with electricty. Perhaps that is why the ancients used to think amber was a witches' stone, and wore ornaments made of it for charms. It is certain that our word "electricity" comes from the Greek word meaning "amber."

How Amber Tells an Ancient Story

Electricity no longer seems to us like witchcraft, but we still admire amber, although not for the making of charms. We have found a way not to waste even the scraps left over from working on it. These used to be thrown away, but now they are heated under pressure and then pressed into large cakes; when cooled these are exactly the same as the natural lumps. The things caught in the amber tell us much of life in those antique days. And "clouded amber," which looks as though a fog had been imprisoned in it, saves for us some of the very air of that time, for the cloudiness is due to tiny air bubbles caught in the gum.

More amber comes from East Prussia than from anywhere else. But you never can tell where the waves will wash up a lump or two of it. Only a few years ago a piece was found on Staten Island, within the limits of New York City.

What Is a Broom Made of?

Imagine sweeping out the dirt with a bunch of flowers! That is exactly what we do whenever we use a broom. For brooms and whisk brooms are all made of bundles of dried flower stalks of the plant called broom corn.

This kind of corn is only a second cousin of the Indian corn whose ripe kernels we munch with such relish It is a member of the family of sorghums (sôr'gŭm), tall grasses which have many other uses besides the making of brooms. One sorghum produces sorghum sirup, which is clear and sweet as molasses. Others produce grain; and one, the Johnson grass, is a valuable "fodder," or food for animals. Most of these grasses are now grown in America as well as in the Orient.

But one group of sorghums is grown only for its stiff, wiry flower clusters. The flowers are a little like those of Indian corn, but the grain is not good to eat. It is the flower stalks that are useful. They are long, plumelike, and very tough, and when bunched together make excellent brooms.

Of course that is why we call this sorghum broom corn, and why we grow a great deal of it so that we may keep our houses clean. There are several varieties. Some have long flower stalks and make long brooms; then

there is a dwarf variety with such short stalks that they are made into whisk brooms. The growers, quite appropriately, speak of the flower clusters as the "brush."

Broom corn is almost a desert plant. It has nearly twice as many roots as Indian corn, and can get along on very little water. Perhaps that is why its flower clusters get so tough and wiry, and consequently so convenient for careful housewives.

The Amazing Story of Petrified Wood

If you ever happen to travel in Arizona or certain other parts of the West, some curio dealer will be sure to try to sell you a bit of beautifully colored stone that looks like polished wood. It is used only in the making of curios. If you just look at it, without feeling its hardness or testing its weight, you may very easily think that it really is wood.

The curio dealer will say, "It is petrified wood." He will mean that it is wood which has turned into stone. But you will have to go to the geologists to hear how this wonder came about.

It did not happen all in a moment, as people were turned to stone in the old legend of the Medusa. Nature does just as strange things as that, but she usually does them very deliberately. The making of her petrified (pĕt′rĭ-fī) forests took millions of years.

Perhaps sixty million years ago there were dense forests in the regions around Arizona, one of the places where petrified wood is now found. Arizona is desert to-day, but in that far-away past not only did trees grow there, but when they fell they fell into water. They were soon covered by a muddy slime of water and fine silt.

Such a fallen tree would become waterlogged, and would float around half sunk in the water until, perhaps, it came to rest against a sand bar. Here it would lie—perhaps for millions of years. Little by little a very slow chemical change would be taking place, a change due to the composition of the wood, the water, and the minerals carried in the water.

This is what was happening: very gradually the woody tissue was being replaced by the slimy water and the silt. As each particle of the wood rotted away its place would be taken by a filmy mass of silt, until finally the log would be a log no longer, but a piece of soft rock. But the soft rock would be exactly like the log in shape and structure, down to the finest wood cell or pore.

A silty "log" like this would never of itself make the hard, beautifully polished and colored petrified wood your curio dealer offers you. But the "log" did not stay stranded in the water forever. The climate was changing and geology was writing another chapter in the history of Arizona. In time the "log" was surrounded by fresh deposits of gravel or coarse sand, too coarse to enter into its structure as the silt had. Then our "log" was slowly covered, along with its fellows, by layer after layer of the sand. After another million years or so the whole mass, "logs" and all, would be buried deep in the earth. Then enormous pressure weighed upon it for uncounted ages. It is this final long-continued pressure which turned the "log" into real stone—made it into "petrified" wood.

A Forest of Stone Trees

So in a way the curio you buy is really wood, and in a way it is not wood at all. More exactly, it is rock which has driven out wood and taken the form of the wood for itself.

The petrified logs on the surface of the earth to-day have been uncovered by the lashing of the elements. In Arizona there are over a hundred square miles of these deposits; and in 1906 the region was made into a National Monument of Petrified Forests. The logs here are all from fallen trees, and must have had some such strange history as we have described. But in Yellowstone Park are stumps and trunks of petrified trees standing just as they grew. These cannot have had exactly the same story, of course, but the process must have been very similar after all.

One does not have to read fairy tales to learn of marvels!

Reading Unit
No. 1

WHICH ANIMALS CAN WE EAT?

Note: For basic information not found on this page, consult the general Index, Vol. 15.

For statistical and current facts, consult the Richards Year Book Index.

Interesting Facts Explained

What is meant by "meat"? 9–317
Why meat is important in our diet, 9–317
How man made sure he would have meat whenever he wanted it, 9–318
Where most of our meat comes from, 9–318
How much meat does the United States produce each year? 9–318
The work of the cowboy, 9–320
Cattle raising to-day, 9–320

Things to Think About

What is the best source of proteins?
Why did ancient man have to eat all his meat at one time?
What birds are eaten for food by man?
What special skills did cowboys need?
How have railroads changed methods of cattle raising?
How has cold storage affected the meat industry?
Why do many people think it wrong to eat meat?

Picture Hunt

Why did man tame certain animals? 9–317
What has happened to the Wild West? 9–318
Why are cattle branded? 9–319
What animal was always feared by herdsmen? 9–319
What kind of cattle was almost wiped out by man? 9–320
What animals have replaced the American bison? 9–320

Related Material

Why have the buffalo and the Indian almost disappeared? 7–279
How does the body use protein? 2–361-63
How did Buffalo Bill get his name? 7–279
How is refrigeration made possible? 10–514, 519

Leisure-time Activities

PROJECT NO. 1: Visit an ice making plant, 10–517.
PROJECT NO. 2: If possible, visit a meat-packing concern and learn how long meat may be stored there, 9–324-25.

Summary Statement

Prehistoric man had to hunt for his meat, and ate it as soon as he found it, because he knew no way of preserving it. To-day, we herd the tame cattle and so have a ready supply of meat at all times. In cold storage we can preserve dressed meat for months.

Long before the dawn of history man had tamed a good many of the animals, for his herds gave him a much more certain food supply than hunting did. Most of those animals are still herded to-day.

WHICH ANIMALS CAN WE EAT?

Why Is It That a Beast with a Hoof Makes a Fine Roast, While the Flesh of a Four-footed Animal with Claws Is Likely to Turn Our Stomachs?

A FEW years ago someone put a cow into one of the big parks in New York, just so that the boys and girls there might have a chance to see one. The boys and girls had been drinking milk and eating beef all their lives, but half of them had never seen a cow! They had really seen the lions oftener—at the zoo.

Since that is so, we may as well talk a little while about where our meat comes from and the animals that give it to us.

First of all, what is meat? Long ago the word was used for any kind of food, and even now when we say "meat and drink" we really mean "food and drink." But the word now means the flesh of a certain few animals, mainly cattle, sheep, and swine--they are almost the only four-footed beasts we eat. The flesh of fish is never called meat, and that of birds usually goes under the name of the bird it comes from.

So when we speak of meat we almost surely mean the flesh of cattle or sheep or pigs. The main reason why their flesh is so important for us is that meat is rich in protein (prō'tē-ĭn), a substance that builds us up and makes us strong.

Now there was a time when all the animals were wild, and when man was about as wild as any animal. In those days he went out and killed any animal that he could eat; and he then ate far more flesh and far less grain and vegetables than he does now. If he had good luck, he might have a great feast; if not, he would go hungry for a while—for it was some time

before he found out how to keep his meat from spoiling.

But there came to be more and more men in the world, and fewer and fewer animals. The men had killed too many, and now they had to do something about the situation. So they started to tame the animals. Then they could kill one when they needed it, without going on a hunt; and far more important, they could breed the animals and have far more of them right around the home than there had ever been in the forests before.

Of course the animals were not tamed for meat alone. Some of them were used for beasts of burden, some for their milk, their wool, their eggs; some even mainly for the fun they gave as pets. But mostly they were tamed and kept for the food they gave. And so it has kept on down to our day, when herds and droves in millions are kept for food all over the world—though not right around most of our homes!

Photo by Weary & Alford Co

The wild, dangerous life of the open plains is fast disappearing, and with it the hardy "ranger," who feared neither man nor beast and was as cool in the midst of a mad stampede of cattle as the modern traffic policeman is in a crowded thoroughfare.

Still there are only a few animals that we have found it wise or possible to tame. Many of them cannot be tamed, because they are too fierce or because they die out in captivity. Many of them, including nearly all the flesh-eating animals—lions, tigers, and the other big cats, wolves, dogs, and foxes—are hardly fit for man to eat. Only a few of the creatures with claws are good for eating—though rabbits and squirrels are often eaten, and occasionally bears, raccoons, and opossums.

Hoofs and Meat

Nearly all our meat comes from animals with two-toed hoofs, and the vast part of this from cattle, sheep, and swine; some of it, in various lands, from goats, buffaloes, yaks, reindeer, llamas, and alpacas. Even among the hoofed animals there are many that do not thrive when tamed; so various kinds of deer, antelopes, goats, and sheep are still left wild, though they are hunted as game and are excellent meat when brought in.

With the birds it is about the same way. The birds of prey, like the eagles, hawks, and owls, are not good to eat. Many of the others cannot be tamed or do not thrive in captivity, though some of them are hunted for their flesh—pheasants, grouse, ptarmigan, partridges, quails, snipes, plovers, woodcocks, and several kinds of geese, ducks, and pigeons that remain game birds because they always stay wild. Only a few birds have been tamed for food—mainly chickens, geese, ducks, turkeys, and pigeons.

The vast part of our meat comes from the cattle, sheep, and swine that we raise. To give some idea of it, we may say that in the United States alone we produce several million tons of beef a year, still more pork than beef, hundreds of thousands of tons of veal, and nearly as much lamb and mutton.

The Western Cowpunchers

This makes a tremendous industry. Some of the animals may be seen almost anywhere we may go into the country, but the vast herds and droves of them grow up in the West to fill the great plains where the bison once grazed in peace. Millions of cattle, in herds of tens of thousands, were turned into the prairies by the ranchmen who owned them and put under the care of the cowboys who kept guard over them. It was an exciting life, and what we

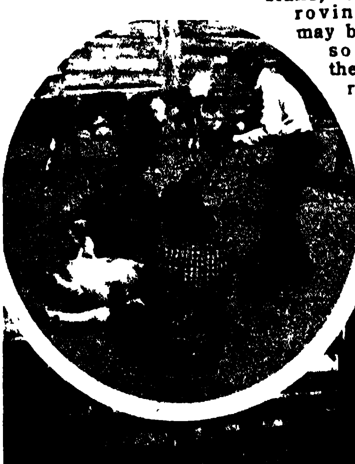
More and more of these gentle dairy cows now graze on the plains where the long-horned Texas steer used to roam at will.

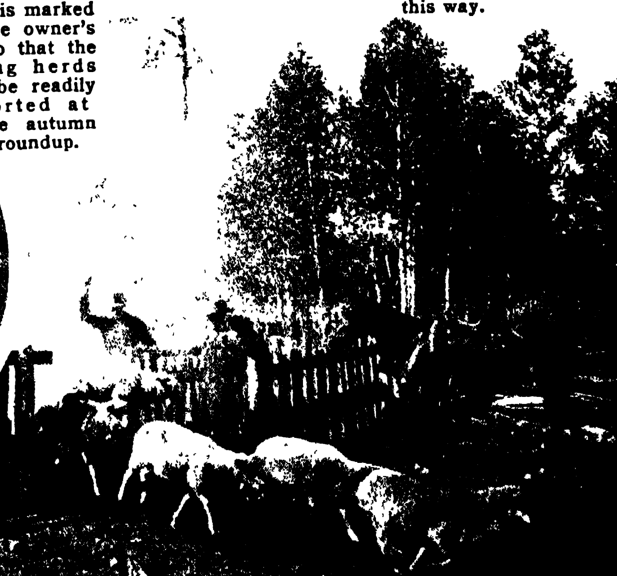
At the left are two of the cowboys who do the work to-day on the western ranches.

Ever since the first herdsman kept the first herd the threatening howl of the wolf has struck dismay to the shepherd's heart. The relentless, skulking beasts hunt in packs, and nothing can frighten them away when they are hungry. They will wipe out a whole flock in a single night.

Oval: Branding a steer with a hot iron. On the western ranches every creature is marked with the owner's brand, so that the roving herds may be readily sorted at the autumn roundup.

Below: Counting sheep that are being turned into one of our national parks for a season's grazing. Anyone who has tried to count a flock of chickens will know why sheep are counted in this way.





call the "Wild West" grew up around the herds.

The cowboys were a hardy and fearless race, expert in the saddle and dead shots with the rifle or revolver. They needed all their skill and bravery to round up their half-wild herds and to keep them safe from wolves and mountain lions, from Indians and from the white cattle thieves called "rustlers." And a whole legend and literature of cowboy life took form around these men, as we see it in many a moving picture to this day.

On the screen and in the circus we have seen them do their marvels with their ponies, their guns, and their lassos. But in the old days out West the marvels were everyday matters, because they had to be. A man had to do wonders on his pony if he was going to stop a few thousand cattle that were starting a stampede, and still other wonders with his rope if he was going to tie up every cow to brand the owner's mark on her; and yet more wonders if he was going to keep off all the clever Indians and rustlers who were always ready to drive off a section of the herd over the open plain.

And then the cowboy had his work when the time came to drive a herd to market. The herd could not go very fast, for it had to graze every day. It must be kept near the water. Every night it must be rounded up and guarded by the cowboys all around it. Every day it must push on.

Now it is all changed. The ranches have wire fences all around them. The wolves and mountain lions are far fewer. The trains carry the beasts to market. The bad Indians have gone to the happy hunting grounds, and the rustlers know that cattle cannot travel so fast as cowboys in automobiles. The cowboy is going too; in a few more years the lasso is likely to be a lost art.

The raising of the cattle is only half of the meat industry. Putting it on the market and distributing it all over the world is the other half. And vast as it is, that is really a very modern business. It was built up only after we found out all about cold storage and canning; it was then that the vast stockyards and packing houses grew up. To-day they give us the great bulk of our meat, though quick freezing in small local units is fast coming into favor.

Long before the pioneers drove the fifst cow westward, the great plains of North America were covered with herds of buffaloes, cousins to the cattle that still graze there to-day. Those were the creatures that furnished fresh meat to the Indians, who hunted them on their swift ponies or in ambush shot them down with bow and arrow. Then the white man came, and the magnificent creatures were slaughtered so cruelly and so recklessly that only a handful are left to-day.

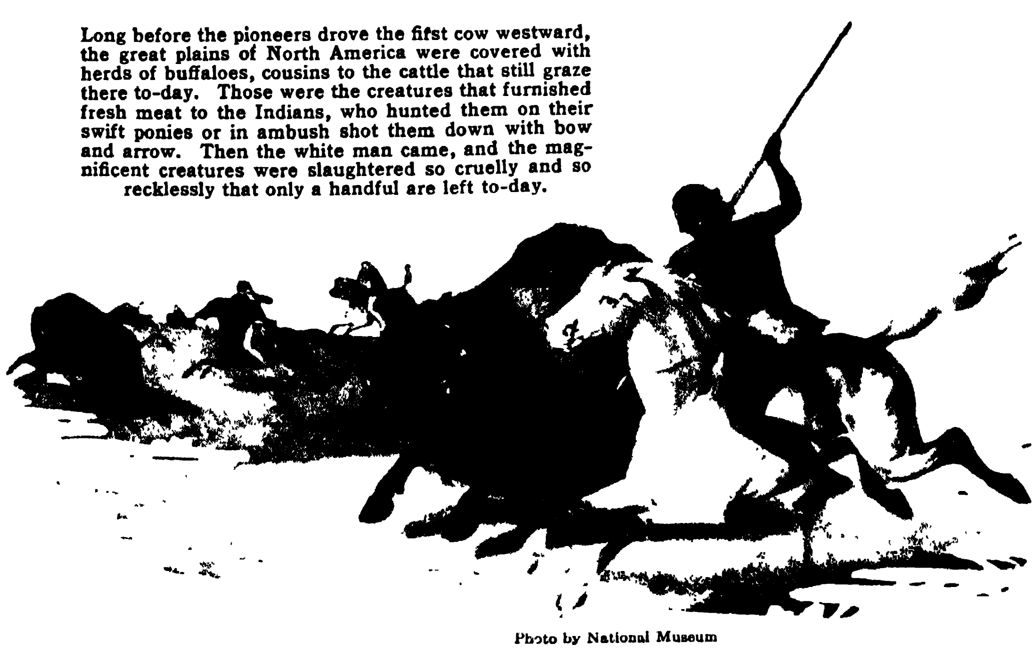


Photo by National Museum

Reading Unit No. 2

WHERE OUR MEAT COMES FROM

Note: For basic information not found on this page, consult the general Index, Vol. 15.

For statistical and current facts, consult the Richards Year Book Index.

Interesting Facts Explained

How the butcher's industry started, 9–323
How the packing houses were made possible, 9–323-24
Old-time methods of preserving beef, 9–326
How meat animals are sent to the packing houses, 9–326
How animals are handled in the packing house, 9–326-28
The products from each animal, 9–328, 329
Stockyards, 9–329

Things to Think About

Why was a great deal of meat wasted in the past?
How did trains and refrigerator cars create meat centers?
What causes meat to spoil?
How did people years ago keep meat from spoiling?
How can you be sure that the meat you eat came from healthy animals?
Does a modern well-to-do man eat more or less meat than the same man did a century ago?

Picture Hunt

What do we do with most of the corn grown in the United States? 9–325
From what part of the animal does chuck steak come? 9–328

Related Material

Why were cowboys necessary years ago? 9–318-20
How many ways are there of obtaining ice? 10–514-19
How can you keep food fresh when you go camping? 14–552
What are bacteria? 2–12, 21

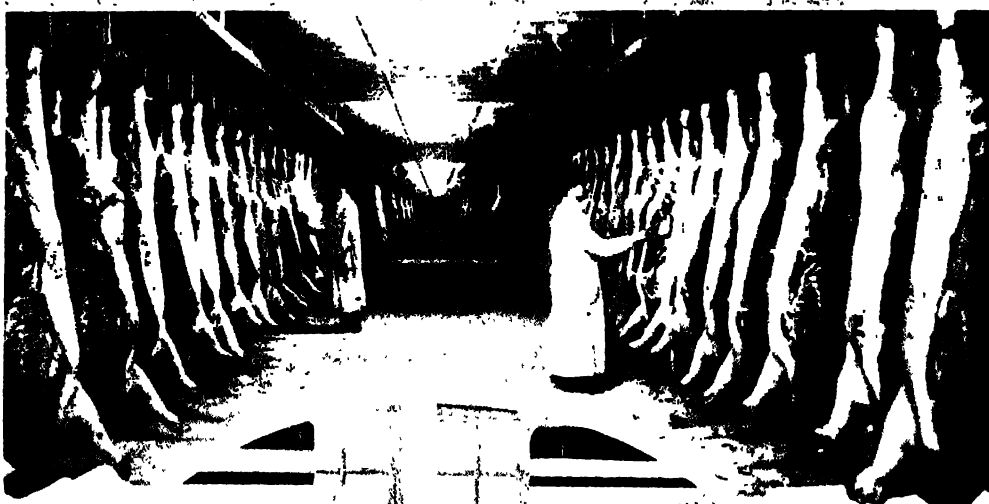
Leisure-time Activities

PROJECT NO. 1: Learn from what parts of the animal the different cuts of meat come, 9–328.
PROJECT NO. 2: Visit a big market to which carloads of meat are shipped daily. Study the refrigerator cars and the handling of the meat, 9–329.

Summary Statement

In days gone by, each locality had a few butchers who actually killed and cut up animals for meat, because there was no way of getting meat from great distances. The railroads changed all this, and now we buy meat in stores. Beef cattle are raised out West, shipped comfortably in cattle cars to a great city, and there are painlessly killed. Then they are cut up, and the meat is inspected by government agents.

WHERE OUR MEAT COMES FROM



The pork hanging above has been inspected four times by government officials in the packing house, and is now hanging up to cool before going to the cutting room - shown below. There each workman, with one deft stroke, removes a cut. Hams now go to be "cured" in sweetened brine for from 45 to 100 days, and are then hung in ovenlike compartments and smoked for from 36 hours to 7 days,—depending on the size of the ham. Trimmings from choice cuts are made into sausage. The girls at the left are packing Frankfurters, made of pork and beef.

Above: In the smokehouse, where hams are smoked in hardwood smoke.

© by Swift & Co.

Our boy is very proud of his jolly little porker, for he raised the animal himself, and has just seen it take a prize. This young stock grower belongs to one of Uncle Sam's prize stock clubs.

Photo by U S Dept. of Agriculture

It Is a Long Story from the Day When Men Just Ate a Beast Where They Could Find Him to the Day When We "Pack" Fifteen Million Animals a Year in a Single City

ALL over town the butchers are selling beef, and all over the country the farmers are raising cows. Yet the butchers never buy them from the farmers. They may even go on selling beef for many a year without ever seeing a cow. So where does the butcher get his beef?

It is quite a story, and it goes back a long way. Of course there was a time when every man was his own butcher. He just killed an animal and ate it—and he ate it right on the spot, or very near, since he knew no way to keep the meat from spoiling. As the years went on, he found out a good deal about raising his own animals for food, and about keeping the meat. By that time there were a few men who took the job of killing all the animals that were to be eaten. Then the farmer raised the animals and sold them to the butcher; and the butcher prepared the meat and sold it to everybody.

And that was the way all down through the centuries to our own time. But in our own day there has been a vast change. Now there are really no butchers left at all, of the kind our fathers used to know, although any man who sells meat is still called a "butcher."

When our fathers were boys, every farmer was raising cattle and hogs, and possibly a few sheep. On the farm he killed as many of these as his own family would need to eat. The rest he drove into town and sold to the butcher there; and the butcher sold the meat to his customers.

Now that was a wasteful system. For one thing, nearly all the parts of the animal that could not be eaten at once were simply thrown away. In the small quantities in which the butcher dealt, it did not pay to keep these parts, and a vast amount of wealth was wasted. For another thing, there had to be a great many little butchers, scattered all over the country, for the animals could not be driven very far to market; and there was a good deal of waste in having so many men in many places doing what a few of them in one place could do better.

Photos by Swift & Co., and Swiss Nat'l Rys.

In many countries meat is still hung up outdoors to dry—an open invitation to all insects and disease-breeding germs to come and make merry. But in the large packing houses as shown in the inset every precaution is taken to protect meat, and so to safeguard the health of those who will eat it.

And for still another thing, the ways of keeping meat from spoiling were still a little primitive; so the butcher could handle only a small quantity, and could hardly ship it at all.

But it was the best that could be done. The farmer had no trains to take his animals far off to some great packing center, but must sell them right at home. The butcher had no refrigerator cars to carry his meat all over the world, but must sell it over his own counter. And so they kept right on in the ancient fashion.

Glimpses at a Great Packing House

Then came the fast train, and the farmer could send his beasts a long way to the market. Then came also the refrigerator car, and the butcher could ship his fresh meat all over the world. These two things made a revolution in the business. There arose a few great centers to which the beasts could be sent from all over the country and from which the meat could be shipped out all over the world. At that moment the little local butchers disappeared, and the vast packing houses came to the fore.

The packing house is so big that it works with a great saving, each man doing his own bit quickly and expertly. It is so rich that it can employ every aid of science to give us good, wholesome food. It deals in such vast quantities that it can save all the parts of animals which used to be thrown away, and turn all these by-products into wealth. The result is that people in England may now get better beef from Chicago or Argentina than they ever used to buy from their own local butcher, and may have a hundred other kinds of things, from glue to buttons, made out of the parts of the beasts that used to be thrown away. And all these

Photos Upi

U S D A photo by Ed Hu

Meat is raised by people. To grow the prize creatures at the upper right took hard work, knowledge, and skill. The boy with his calf and the brothers and sisters with their sheep are learning a difficult but fascinating calling.

things they can have cheaper than before.

Now before we go on talking about the great packing houses, we might say a word about the ways we used to have of keeping meat long before there were any such houses.

Meat spoils only because certain bacteria (băk-tē′rĭ-ȧ)—which are very tiny plants—get into it, and long ago we found out several ways of keeping the bacteria from working. They cannot work in the cold. So if meat is put on ice, it will last for a good while, and if it can be kept frozen it will stay good for years. Nor can the bacteria work in perfectly dry meat, for they need water in their industry. That is why the Indians in the deserts and on the plains, where it is very hot and dry, used to keep their meat by cutting it into thin strips and laying it out in the hot sun to dry. It became nearly as hard as leather, but it was still pretty good food when it was soaked again and boiled. The Indians called it "pemmican," but the white people gave it the uglier name of "jerked meat."

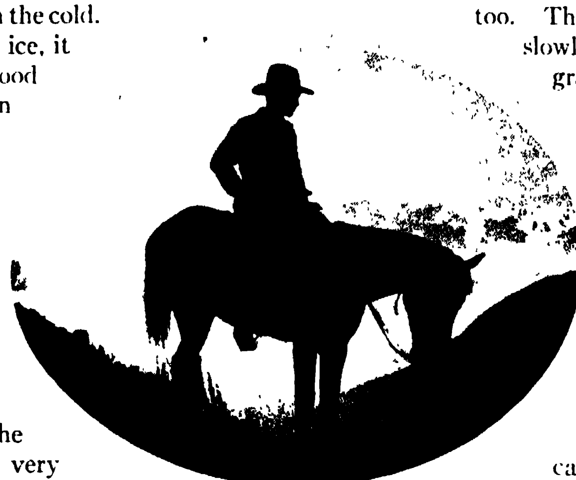


Photo by Northern Pacific Ry.

The old picturesque life of the cowboy is now largely led on the motion-picture screen. Its heroes have gone the way of the knights of old. But there was a day when they ruled the plain; and they will probably live in literature for a long time to come.

In most places the air is too moist to make pemmican. But the white people found out how to dry their meat in the smoke, and so protect it from bacteria. And that is why we still have "smoked ham" and "smoked beef."

Nor can the bacteria work in salt. It draws out the water from their tiny bodies, and so kills them. Long before we began freezing meat, on any large scale, we used to have a great deal of salted meat to last through the winter. We still have plenty of it to-day, as in our hams, though of course we like most of our meat fresh. Now long ago we used to salt our meat by packing it away in barrels with the salt. So the place where we salted meat was called a "packing house." And that is the name that still clings to the great houses in Chicago and elsewhere, whose business is not to salt our meat but to keep it fresh. As so often, we keep the old word for a new thing.

When the vast herds of cattle, sheep, and hogs first began to dot the western plains, they still had to be driven to market on their own feet. That was very wasteful, too. They could go only very slowly, for they had to graze every day. Even then they might lose a good deal of weight on the trip, and they would certainly take many a cowboy's time to herd them and protect them.

But with the railroads came special cars for carrying the beasts. The cars have a good roof, but have plenty of air spaces between the boards on the sides. The animals are packed in close enough to keep them from falling over as the train speeds on, but not so close as to make them suffer. The cars for sheep and hogs are double-decked, and carry twice as many animals as would a car with a single floor.

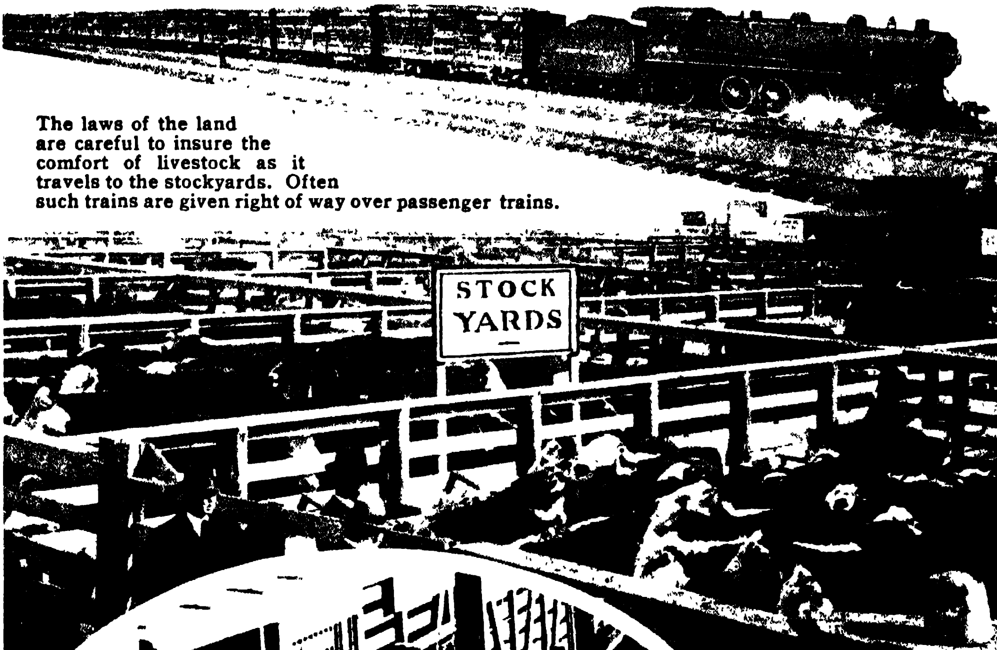
Once the cars are loaded, the train starts off at express speed for the packing house. Everything must be done to get the animals there quickly and in good condition; though if it takes more than twenty-four hours, the train is stopped and the beasts are all unloaded and fed. After a short rest, they will go on again.

Shower Baths for the Hogs

At the end of the trip they are put into small pens with plenty of food and water. Then they are carefully weighed and inspected. Any that are ill or injured are put aside.

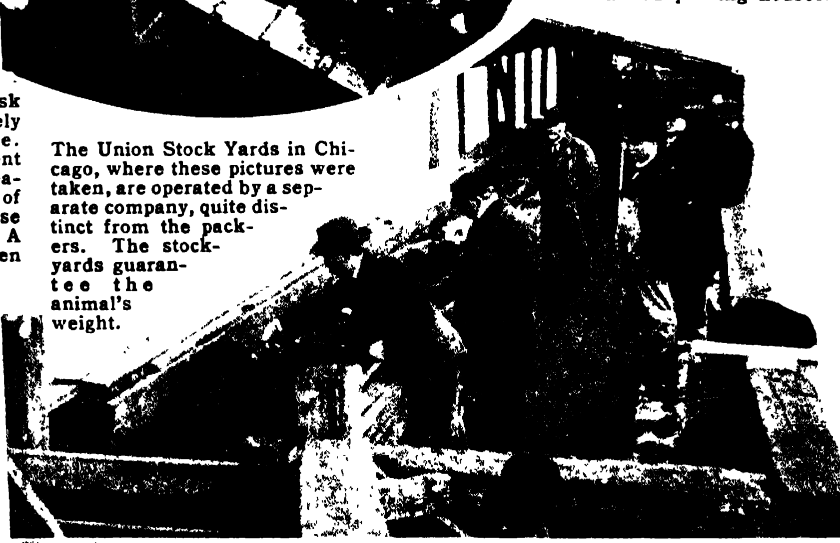
After a rest of a day or two—and after a shower bath for the hogs—the animals are

WHERE OUR MEAT COMES FROM



The laws of the land are careful to insure the comfort of livestock as it travels to the stockyards. Often such trains are given right of way over passenger trains.

When they arrive at the stockyards the animals are unloaded at once into paved pens, where they begin to feed. Then they are inspected by government officials—as shown below—and any that are ill or unsound are removed before the buyers appear to buy for the various packing houses.



The buyer's task is an extremely important one. On his judgment of the live creature the profits of the packing house largely depend. A glance will often tell him how valuable an animal is likely to be as meat. The live stock coming to a stockyard is consigned to a commission firm, which takes a commission from the shipper.

The Union Stock Yards in Chicago, where these pictures were taken, are operated by a separate company, quite distinct from the packers. The stockyards guarantee the animal's weight.

Photos by Swift & Co

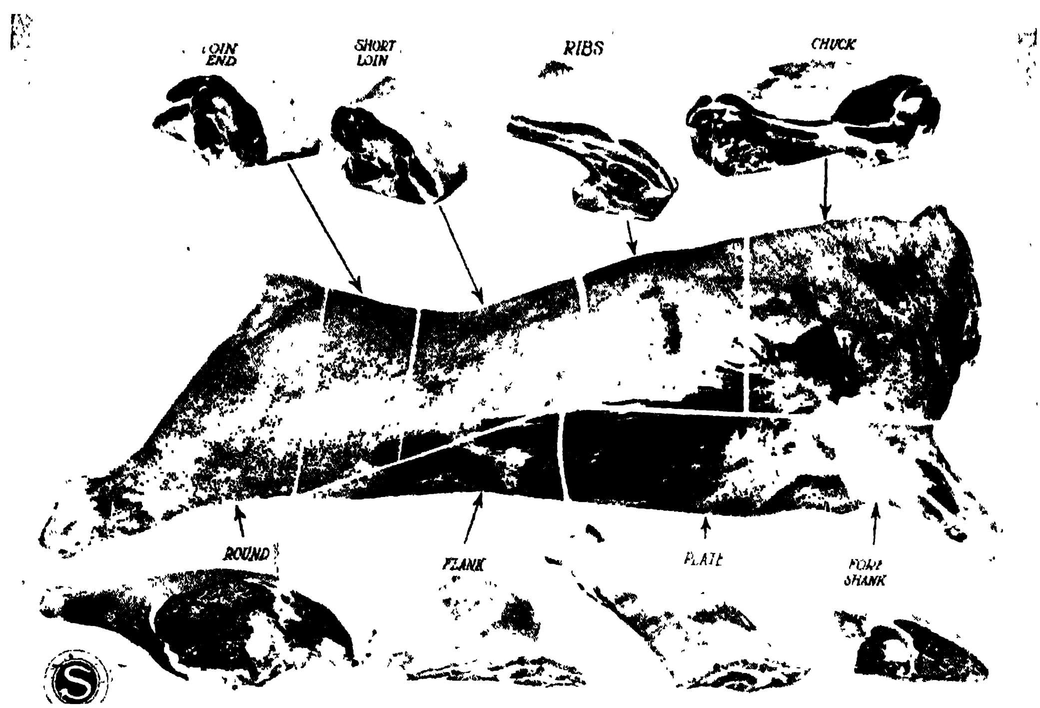


Photo by Swift & Co.

A steer is not all beefsteak. He yields a great many different "cuts," some much less expensive than others and just as nutritious. A skillful housewife knows how to use the cheaper cuts and make them appetizing. Above you may study the geography of the whole creature—and the butcher can tell you still more.

killed. They never suffer, as they sometimes did in the old days of the local butcher. They die instantly, without ever knowing anything about it. And then the marvelous system of the packing takes care of them. The animal is immediately slung on an overhead trolley and carried rapidly past a large crew of expert workmen who skin him and cut him up into the many parts, which all go exactly where they belong. With each workman doing his own little bit at an amazing speed, a big steer will be all carved up and delivered to the cooler in half an hour—though in that time many another steer will have been passed on by each workman.

Where Uncle Sam Steps In

At every point the meat is inspected by government officers. When it is finally ready for shipping it is examined once more; if all is well it is then stamped "U. S. Inspected and Passed." Thus consumers are protected all over the world.

What do we get from one good steer? If he weighs 1,100 pounds, he will give us about 608 pounds of meat, of the following kinds:

Porterhouse and club	53	pounds
Sirloin	47	"
Rib	51	"
Round and rump	97	"
Chuck	131	"
Miscellaneous	229	"
Total	608	"

This leaves 492 pounds that we do not eat. But the hide goes into leather, the oleo oil into oleomargarine (ō′lē-ō-mär′jȧ-rēn), the horns into combs, brush handles, and many other things, the bones into buttons, knife handles, and all sorts of knickknacks. Nor is that all. The hoofs make glue, and the intestines make coverings for sausage—those of the sheep making strings for musical instruments and tennis rackets. We call it "catgut," but we get it from the sheep. The soft hairs from

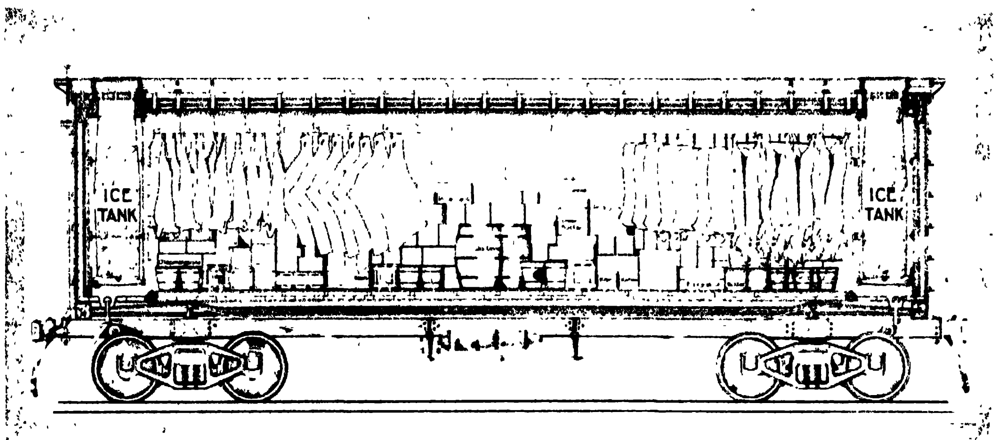


Photo by Swift & Co

When fresh meat goes traveling overland it has its own "Pullman" coach. A reffigerator car, such as is shown above, is kept at a low temperature but is never so cold as to freeze its contents.

the cows' ears give us "camel's hair" brushes. The waste fats and lards make soap, and anything that will do for nothing else is turned into fertilizer—to grow more grass, to feed more animals! Nothing goes to waste.

These are just a few of the "by-products" of the packers. They make the world a great deal richer. Anyone can see that before the day of the great packers about four hundred pounds of every steer was thrown away.

In hogs there was much less waste. A hog is so fat that if he weighs 300 pounds, we can eat 240 pounds of him. But there are many things to do with the rest. The pork we get from hogs is sold either fresh or "prepared." The ham and shoulders may be first pickled and then smoked for some twelve hours. The sides are made into bacon. Nearly all beef and mutton is eaten fresh. And large amounts of the meat from all three animals are made into sausage.

From the packers the meat goes in refrigerator cars all over the country to branches in many cities and indeed to dealers in many parts of the earth.

The Union Stock Yards in Chicago are the largest in the world, and are one of the marvels of big business. Thousands of people go to see them every year. For over three quarters of a century Illinois has handled each month many hundreds of thousands of animals, valued at millions of dollars.

Where Are the Big Stockyards?

There are similar stockyards in many other cities, but the largest ones are in the great "corn belt" of the upper Mississippi Valley and in Texas. It is in these regions that most of the stock is raised. For corn is the best food to fatten cattle, and especially to fatten hogs. With so much corn, it is no wonder that the United States grows more hogs than any other country. There are ten million of them every year in Iowa alone. So outside Chicago, the greatest packing houses are in or near Kansas City, Omaha, East St. Louis, South St. Paul, Sioux City, St. Joseph, Fort Worth, Pittsburgh, and Denver.

In the export of beef to other lands the United States ranks high among the countries of the world. Argentina, Uruguay, Australia, and Holland are other leading exporters. In the export of pork the United States leads, followed by Denmark, Holland, Ireland, and Canada.

WHERE OUR MILK COMES FROM

Reading Unit No. 3

"THE FRIENDLY COW, ALL RED AND WHITE"

Note: For basic information not found on this page, consult the general Index, Vol. 15.

For statistical and current facts, consult the Richards Year Book Index.

Interesting Facts Explained

The products we get from the cow, 9–331
Milk from animals other than the cow, 9–332
The cow's ancestors, 9–332
Different breeds of cattle, 9–333-34
The amount of milk a cow can give, 9–332-34
Why milk is carefully handled during and after milking, 9–335
How you get safe milk at your door, 9–335-38
How evaporated and condensed milk are made, 9–338

Things to Think About

Why is a cow valuable, dead or alive?
How did man breed the cow of to-day?
What are the special qualities of the four favorite breeds of dairy cows in this country?
What are the records for milk and butter fat production?
Would goats be more convenient milk animals than cows?

Related Material

Where does the word "pecuniary" come from? 7–503
How do bacteria help us to make cheese from milk? 2–20
How did Louis Pasteur's work make our lives safer? 13–367-68

Leisure-time Activities

PROJECT NO. 1: Visit a large dairy at milking time, 9–335-36.
PROJECT NO. 2: Visit a creamery near your home, 9–337.
PROJECT NO. 3: Pour some fresh milk into a bottle that has been boiled, and cork it with a boiled cork. Let it stand on your window sill. What happens to warm milk on standing? Why should we keep milk cold?

Summary Statement

Dairy cattle are not bred for meat, but for milk and cream production. The milk is kept as free from bacteria as is possible and is carefully refrigerated. It is pasteurized to kill harmful bacteria, and shipped in sterile tanks or bottled in sterile bottles.

Photo ... The Borden Company

On a dairy farm everything centers around the big barn. Here are the machines that milk the cows and the ones that separate the rich cream from the skim milk. In bad weather the cows stay in the barn, where they are fed on fermented fodder that has been stored in the silo – the tall white tower standing close to the barn. But in fine weather they wander about, safe and happy behind fences that keep them out of trouble.

"*The* FRIENDLY COW, ALL RED *and* WHITE"

This Is the Story of All That Is Done in Dairies, Big and Little

MAN thinks of himself as the lord of creation, but how badly off he would be without his faithful animals to serve him! How meager his food would seem, and how chilly his clothing! Most of all he would miss the cow. She has been called man's best friend. All her life she gives us her milk, the best food there is for babies and growing children and one that we can make into cheese and butter besides. And when she is dead she gives us her flesh to make beef, her hide to tan for leather, her hair for mattresses, her hoofs for glue, her bones for buttons and knife handles, and other parts for soap and fertilizer. She pays us many times over for the grass and hay, the corn and oats and bran, that are her simple diet.

But there is one thing she asks besides her keep, and one thing she must have. That is kindness. If her milk is to be rich and flow in abundance she must always be treated gently, must be kept clean and comfortable, and given intelligent, patient attention.

She is not a newcomer among us. For century upon century she has been our friend. The lake dwellers, who lived in Switzerland ten or twelve thousand years ago, kept cattle like ours, and so did the early Egyptians. In those days the milk was not so valuable. There was much less of it, and during the winter cows "went dry." But plowing and other heavy work was done by oxen long after men had tamed the horse. Those sturdy, patient beasts

Photo by Ewing Galloway

This serious face belongs to a milking shorthorn. In return for her careful breeding, she will give rich milk.

helped the pioneers to break many an acre in our own new land.

Various other animals used to help the cow furnish our milk supply. In many countries to-day sheep and goats are kept for their milk. In the deserts of Asia and Africa men get it from camels, in India from the zebu and water buffalo, in Tibet from the yak, in Lapland and Northern Siberia from the reindeer, and in Arabia and a few other places from horses and donkeys.

But none of these animals can compete with the cow—partly because she has been improved by centuries of breeding and partly because she is descended from ancestors that were themselves good milk producers. For you must know that cows, as we have them to-day, never lived in a wild state. They are the result of the taming and crossing of a good many different animals, some of which still roam the plains and forests of Asia and Africa. The urus, gaur, zebu, banteng, and buffalo are all thought to be forebears of the cow. Of these all but the last are natives of India, Indo-China, and Malaya. The buffalo is an American cousin to them, closely related to the yak of Central Asia.

Of course there are a great many kinds of cattle to-day. Some are raised mainly for beef and others mainly for milk, for the best milkers are usually poor for beef and the best beef cattle, as a rule, are not good milk producers. Dairymen do not agree as to which breed is best for their purposes. In America the most popular breeds are the Holstein (hōl′stīn), Jersey, Guernsey (gûrn′-zĭ), and Ayrshire, in the order named. But the Shorthorn, Brown Swiss, Dutch Belted, Devon, and Norfolk find favor in some places.

The Holstein comes to us from Holland, and was known in the valley of the Rhine two thousand years ago. The herds of handsome big black-and-white cows that you see from the car window are Holsteins. They are famous for the amount of milk they will give.

Where the Jersey Comes From

Two little islands in the English Channel give us the two next most popular breeds for Jerseys and Guernseys are named for the islands they came from. Milk from these cattle is very rich and finely flavored. The two breeds are closely related but may be told apart easily enough. Both are small, lean, and graceful, and are colored a beautiful soft tan; but the Guernsey is larger than the Jersey and is marked with white. Jerseys were being bred before America was ever discovered.

The hardy Ayrshire comes to us from Scotland, and thrives in a cold climate, like that of Canada. But it is beginning to make its way in warmer countries, such as Mexico and Australia.

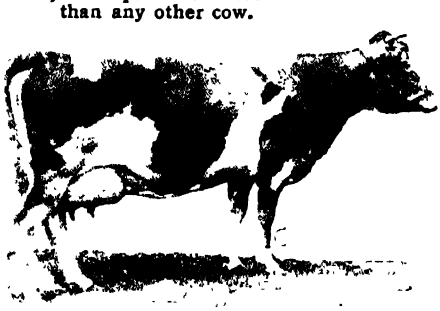
The Shorthorn, formerly called the Durham, is an all-round breed of English origin. It can suit itself to all sorts of conditions, and has made some unusual records in butter and milk production. From England come the Devon and the Norfolk, too. Holland sends us the Dutch Belted, and Switzerland the Brown Swiss. All of them have found favor in the New World.

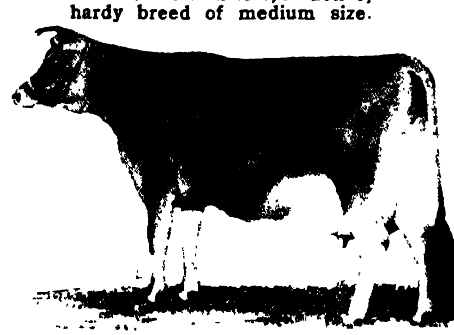
The dairymaids who milked the cows at

WHERE OUR MILK COMES FROM

A—The black-and-white Holstein, which produces more milk than any other cow.

B—The Brown Swiss, an active, hardy breed of medium size.

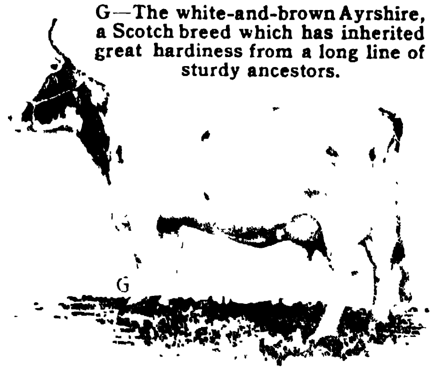




C—The graceful, gentle Guernsey, of a soft tan and white.

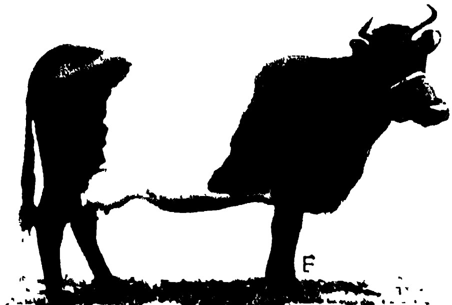
The different breeds of cattle in the world to-day grew up under widely varying conditions, and the members of each breed tend to thrive best in a climate such as their ancestors were used to. So one breed does well in one place, and another breed in another place.

G—The white-and-brown Ayrshire, a Scotch breed which has inherited great hardiness from a long line of sturdy ancestors.

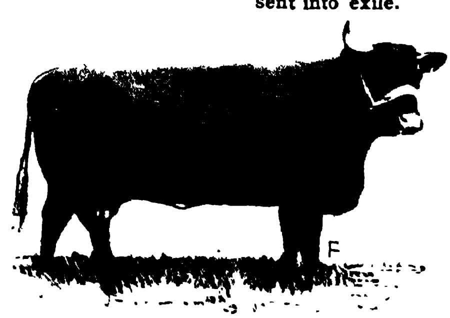


D—The dainty Jersey, much like a deer in form and coloring.

Cattle were so important to early men that wealth was measured in them. We are told that Abraham was rich in cattle, and bills often were paid in oxen instead of in coins. That is why the Greeks, when they began to use money, stamped it with the figure of an ox. The Egyptians worshiped a bull, and the Hindus were forbidden to shed the blood of an ox. And any Roman who killed an ox without some good reason for doing so was sent into exile.



E—Dutch Belted, jet black with a white belt. The breed came originally from Holland.



F—The Devon, a small, hardy, red cow that comes from Devonshire, in England.

...to by U. S. Dept. of Agriculture

Photo by Ewing Galloway

Few cows are pampered as these New York State cows are. Their luxurious milking barn is lighted by electricity, heated by steam, and artificially cooled from overhead. Do you wonder that bossy looks self-satisfied?

the time of the Civil War would be amazed if they could suddenly go back to work to-day—they would have to spend a great many more hours milking. Careful breeding and feeding have increased a cow's supply of milk enormously in the past fifty years. The average cow now gives 4,500 pounds of milk a year, with about 180 pounds of butter fat in it. But there are many cows that give over 10,000 pounds of milk in a year, a fair number that give 20,000, some that give 30,000, and a few that are nearing the 40,000-pound mark. To give a large amount of milk a cow must come of a long line of good milkers. One pure-bred cow will produce as much milk in a month as her wild ancestor would produce in a year, and she may earn as much money for her owner as forty cows of inferior breed could earn.

Cows differ greatly as to the richness of their milk. One prize milker gave 33,465 pounds of milk in a year, and in it was 1,349 pounds of butter fat; another cow of the same breed gave 37,381 pounds during the year, but it contained only 1,159 pounds of butter fat. Now the farmer who sells his cream to be made into butter wants to own cows that will turn out milk very rich in fat. But the man who sells his milk whole to the consumer or to a big milk-distributing company is glad to have cows that give a great deal of milk

The Cow That Gives Most Cream

So, you see, it is hard to say what breeds are best. A Holstein will give a great deal of milk, but a Jersey's milk will be richer. She will give her own weight in butter fat in a year. One prize-winning Jersey gave 16,425 pounds of milk in one year, and in it were 1,141 pounds of butter fat—only 18 pounds of butter fat less than was given by a Holstein that produced over 37,000 pounds of milk. Another champion butter producer in the United States was a Holstein which gave 1,500 pounds of butter fat in a year. Naturally she was a possession of the greatest value to her proud owner. She has been beaten by a wide margin, however, for breeds are constantly being improved.

Young cows are called heifers (hĕf'ẽr), and are not known as cows until they have their first calves, which is usually when they are two or three years old. A baby calf is fed on milk alone for the first two weeks. Then a little meal is given it, and when it is big enough to chew a cud it is fed a little grass or hay.

Good pasturage, with a little ground grain, is all a cow needs in summer to give good milk. But in winter the lack of fresh grass must be made up, if she is to keep up her record. For this reason the modern dairy farm in temperate climates often has what is called a silo (sī'lō). This is a tall round air-tight building that looks like a stumpy tower. It is made of cement and is built near the cattle barn. In it is kept green fodder for winter feeding. Usually this fodder—which is called "ensilage" (ĕn'sĭ-lâj), or more often simply "silage" (sī'lâj)—is made up of corn—stalks, leaves, and all—which is chopped into small pieces and put into the silo while the corn is green and full of juice. But clover, alfalfa, cow peas, sunflowers, oats, millet, soybeans, and other green crops are used for silage, too.

Bacteria Grow in the Silo

Now because the silo is air-tight the green stuff in it cannot dry out. And neither does it decay, for those amazing tiny plant forms that we call bacteria (băk-tē'rĭ-à) begin to grow in it and make it ferment—just as they make apple juice "work" or milk turn sour. This ferment keeps the silage from rotting, and so the green food is preserved all winter. Silage is to cattle what canned green vegetables are to us.

The milk that you find in a bottle at your door in the morning has been milked perhaps hundreds of miles away, where great herds browse in peaceful pastures watered by little streams. Twice a day they come lowing, with swollen udders, to the barns to be milked. Sometimes this is done by hand, and then it is hard and skillful work; but often it is done by machine, and then one man can tend the machine that milks every cow in the barn. The workers, the barns, the utensils, and the cows themselves are all kept spotlessly clean. After the milk has been taken from the cow it is strained and cooled at once, in order to keep it from souring, and then it goes rattling off in great cans to the milk station. There it is pasteurized (pås'-tẽr-īz); that is, it is heated, in the bottle, to between 131° and 158° F., is kept at that temperature for a few minutes, and then quickly cooled. This kills all sorts of harmful bacteria and such germs as those of tuberculosis; and besides this, it keeps the milk sweet much longer.

How a City Gets Its Milk

When the milk has been pasteurized it is carefully sealed with a seal that bears the time of pasteurizing, and then it is shipped by train or truck to the distant city. Sometimes it is not pasteurized till it gets there. All night the trains come steaming in, and by four or five in the morning the milk trucks are ready to carry their loads from house to house, and leave every bottle at its own door.

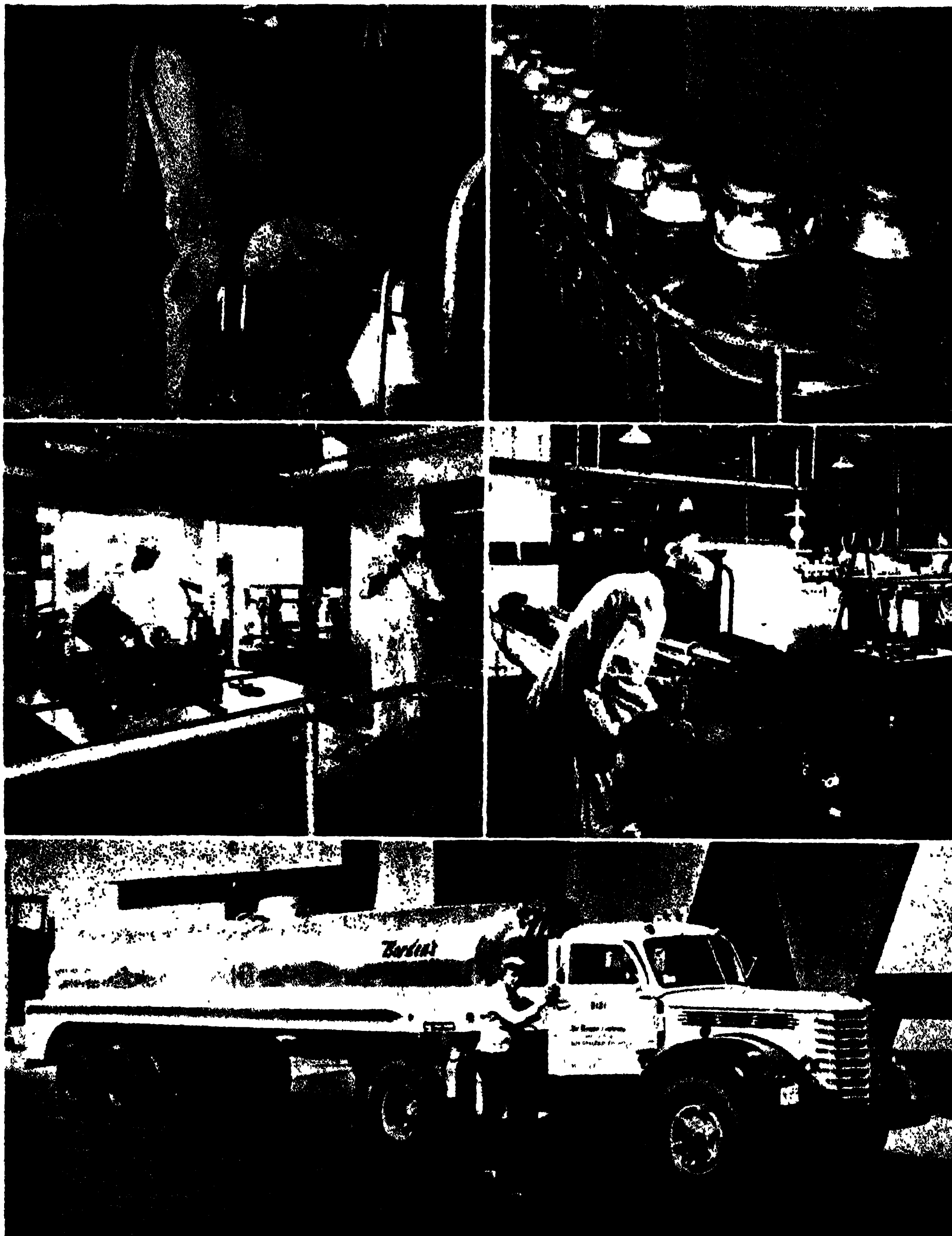
This milk is clean and pure and wholesome, hedged about by law on every side for the protection of the millions of people who will drink it. How different from the day when a single shiftless farmer could spread typhoid germs through a whole community by diluting his milk with impure water!

The city of New York uses hundreds of millions of gallons of milk and many million gallons of cream every year—and every shipment in this great lake of liquid is tested for purity and cleanliness and for freedom from germs.

Of course there are cows in every part of our country; we produce many billions of gallons of milk a year, and the quantity is all the while growing. New York produces more milk and cream for direct sale than any other state, but she is far behind Wisconsin in the total value of her dairy products.

For of course the dairying industry supplies us with a great many things besides raw milk. In the United States it gives us hundreds of millions of pounds of creamery butter a year—and almost half as much again is made on the farms. It gives us thousands of tons of cheese, millions of pounds of condensed and evaporated milk, and hundreds

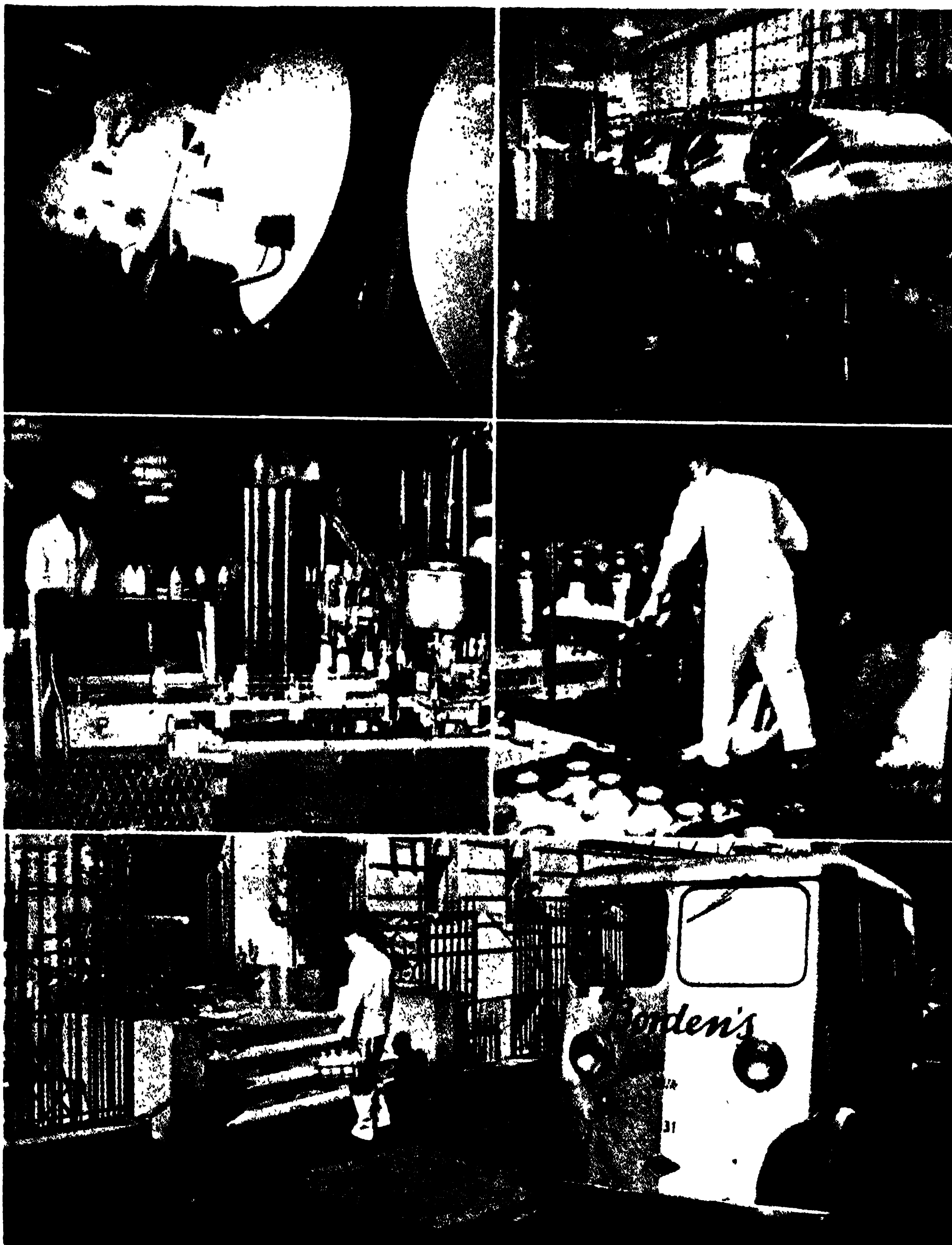
WHERE OUR MILK COMES FROM



Photos courtesy The Borden Company

These pictures show you the progress of milk from the cow to your own door. In a clean stall in her country barn the cow is milked by a sterile machine twice daily. The pure milk is then taken in large cans like those at top right to the receiving station. There, as you see at the left in the center of the page, the milk is poured into a vat, which weighs it. Then the temperature of the milk is taken and a test is made for purity. Because no pains are spared in order to keep the milk pure, all the machinery in this plant is taken apart every 24 hours and thoroughly cleansed. From the country receiving station the milk next goes in insulated tank trucks like the one above to the city pasteurizing plant. Such trucks carry up to 38,000 pounds of milk.

WHERE OUR MILK COMES FROM



Photos courtesy The Borden Company

At the pasteurizing plant the milk is pumped from the tank trucks into these giant glass-lined holding tanks, upper left, which keep the milk at an even 40° F. From the storage tanks it flows to clarifiers to be checked for refuse, and then to the homogenizer. Homogenizing is the process of breaking the butterfat globules into tiny particles which distribute themselves evenly throughout the milk. Then comes pasteurizing, the job of quickly heating the milk in tanks like those at upper right to 160° F. and then rapidly cooling it to 35°. Now the milk is ready for bottling by the machine shown at the left in the middle of this page. Every minute 140 quart bottles are filled and sealed. They are put into cases and sprinkled with ice—and at last are delivered to you.

of millions of gallons of nourishing ice cream.

It is only of late years that the sale of evaporated and condensed milk has grown so large. The first person to can milk was Gail Borden, who started putting it up in 1856 in Connecticut. He added sugar as a preservative. Finally a way was found to "evaporate" unsweetened milk. To do this the milk is heated in a closed metal tank from which the air is drawn out. When it reaches a temperature of about 140° F., the milk begins to boil, for though it is far below 212°, the ordinary boiling point, the water in the evaporating milk can turn to steam at a much lower temperature than would be necessary for boiling it if there were air in the tank. This is a great advantage, for the flavor and quality of the milk are not so much changed as they would be if it were brought to a higher temperature. When about forty percent of the moisture in the milk has been boiled away, the milk is forced through a strainer so fine that the little globules of fat are very much reduced in size and scattered well through the milk Then they cannot rise as cream.

Now, after the government test for quality has been applied by the chemist, the milk is ready to go into cans. It is poured into them through a little round hole in the top of each can, and then the can is sealed with a drop of solder. The can of milk is now sterilized by being brought well above the boiling point. This kills all the bacteria, and the milk will keep indefinitely. In making "condensed" milk, more water is removed than for "evaporated" milk. "Concentrated" milk has been robbed of more water still—and powdered milk is quite dry. All of them are of great use for cooking and other purposes, and may replace milk entirely when necessary.

Photo by Ewing Galloway

In the hush of late afternoon the cows make their way along a sun-flooded lane toward the dairy barn. They have eaten their fill of sweet grass and want now to be milked and turned out into the cool evening pastures.

Reading Unit No. 4

THE STORY OF BUTTER

Note: For basic information not found on this page, consult the general Index, Vol. 15.

For statistical and current facts, consult the Richards Year Book Index.

Interesting Facts Explained

How butter making began, 9–340
How butter was made in the past, 9–340
How butter used to spoil, 9–341
What Pasteur taught us about butter making, 9–341
Creameries that make butter to-day, 9–341-42
How the cream separator saves time, 9–342

Things to Think About

What have donkeys to do with making butter?
What part of milk is used to make butter?
What invisible things often spoiled butter?
How did Louis Pasteur help the butter industry?
Why is salt often added to butter?
Why are bacteria added to sweet cream in making butter?

Picture Hunt

How do women in India make butter? 9–341
Why must a churn have a plunger? 9–341
Why did men once think that a donkey must be used to make butter? 9–341
What is the difference between "tub" and "print" butter? 9–342

Related Material

How did Louis Pasteur help mankind? 13–367-69
What dye is used to give butter an attractive color? 9–305
What is the next best thing to butter? 9–372-73
What is a good substitute for butter when you go camping? 14–552

Leisure-time Activities

PROJECT NO. 1: Buy some fresh, chilled sweet cream. Churn it with an eggbeater or beat it with a spoon in a deep bowl. Butter will float to the top and buttermilk will be the liquid at the bottom.

Summary Statement

Butter was once used as an ointment. It could not be eaten because of its bad taste and odor. To-day, because of the work of scientists like Pasteur, butter is fresh, appetizing, and nutritious. Cream is pasteurized to kill undesirable bacteria, then the proper bacteria are added for flavor. The cream is then churned in big tanks until it turns into butter.

This pretty milkmaid has made her cow look almost as festive as she does herself in her bright peasant costume. A good deal of the world's butter is still made by peasant milkmaids and dairymaids, as in the days of old. But more of it is now made with machines.

Photo by German State Railways

THE STORY *of* BUTTER

This Story Will Tell How Our Golden Butter Has Been Made for Many a Thousand Years

WHAT do you suppose it was that first gave men the strange notion of jolting cream about until it turned to butter? Certainly we might use cream for our coffee and cereal every day for a lifetime and yet never dream that it could be made to yield the rich yellow substance that we like so much on our bread. Now it is true that the first butter maker lived so far back in the past that his name is lost to fame, for butter was known several thousand years ago. But when we say that even to-day there are certain primitive lands where butter is made by jolting the cream along on the backs of trotting donkeys, you can make a shrewd guess as to how we first found out how to make it. For early men who carried milk to quench their thirst on a journey would soon learn not to be surprised tc find masses of yellow fat floating about in it after a good stiff gallop.

But it was a long, long time before butter making became the art that it is to-day. In fact, really good butter was rare even fifty years ago. The sort that men first made must have had a very unpleasant taste, for butter is quick to pick up odors—and early men knew little about cleanliness. And the animal skins in which all liquids had to be carried would hardly improve the butter's already strong flavor. So the men of old did not eat the butter they made from the milk of their sheep and goats. They burned it in lamps or used it as an ointment.

But little by little, as people became more cleanly and cows grew commoner, the ways of making butter improved. The more careful housewives learned to skim off the cream with a ladle and stir or beat it in a bowl or jar until the butter "came." And then they learned to make a plunger, or "dasher," an implement with a long straight handle that carried on its lower end a set of flat wooden bars. This could be worked up and down in a keg of cream, and for a long, long time that was the only kind of churn the dairymaid ever knew. For butter was always made on the farm where the cows were milked, and indeed thousands of farmers' wives make their own butter still.

Now in those days good butter was largely an accident. All sorts of things could spoil it, and no one knew just what they all were.

Of course if the cows got into the onion patch it was easy enough to tell what had gone wrong! But in a day when no one kept ice and flies were plentiful and the milk had to stand in the cellar or spring to keep cool, all kinds of tiny plant organisms—which we know as bacteria (băk-tē′-rĭ-ȧ)—could get a start in the cream and produce enough flavors to bring the farmer's wife to the verge of despair.

Up and down, up and down, she must move the plunger until the butter comes. On many a farm the household still eats butter made from the milk of its own cows.

The donkey may be as stupid as Aesop said he was, but he was probably the first butter maker just the same. As he jolted faithfully along with his master's supply of milk slung over his back, he turned it into butter as well as any churn could do it.

But at last science came to the rescue. About the middle of the last century a great French scientist discovered that it is the presence of bacteria which makes milk sour. His name was Pasteur (pȧs′tûr′), and so we say that milk has been "pasteurized" (pȧs′tĕr-īz) when those bacteria have been killed by a process that he discovered. He found out, too, that the reason why cream that has stood, or "ripened," for a few days will yield up its butter sooner is that lactic acid bacteria have been at work. These two discoveries taught the butter maker how to keep unpleasant odors out of the butter by pasteurizing the cream, and how to ripen the cream by introducing for himself just exactly the right bacteria. Now, if he took pains to keep everything absolutely clean, his butter never went wrong. It was always sweet and appetizing—and the addition of a little salt would make it keep a long time.

Perhaps you have noticed that the butter maker we are speaking of is no longer the housewife or the dairymaid. At about the time when Pasteur's discovery was teaching us how to make good butter, the modern creamery was beginning to appear everywhere in the countryside. This was a factory where butter could be made according to exact, scientific methods. It took the work out of the housewife's hands; and since 1856, when the first creamery was built, in Orange County, New York, the industry has grown so large that we have thousands of creameries, some of which make many millions of pounds of butter a year. The creameries of the United States produce twice as much

In some parts of India to-day the native women use this ingenious device to lighten the work of churning. Even so, it must take a good deal of time. How much easier to telephone to the corner grocery!

butter as those of any other nation—1,600,000,000 pounds a year. Of this vast amount Minnesota makes the most, with Iowa and Wisconsin ranking second and third.

On a modern dairy farm everything is spotlessly clean. The cows are curried and cleaned before they are milked, and everything is done to keep the delicate fluid from picking up odors. As soon as the cows are milked, the milk is run through an amazing machine known as a separator. This has done more than any other machine to make the modern creamery possible, for in a few minutes it takes out the cream that used to need twenty-four or thirty-six hours to rise on the milk. The cream is then cooled —how much faster than when it had to stand for hours in the spring or the cellar! —and sent off to the creamery, either by wagon or by train. At the creamery a neat little test for butter fat—discovered by Professor S. M. Babcock, of the University of Wisconsin—is applied, and the farmer is paid according to the actual amount of fat he delivers.

The sweet cream is then pasteurized and the proper bacteria are added to "ripen" it rapidly, though butter is also made from fresh sweet cream. When the cream is ripe it is put into the churn, a huge tank turned by machinery. Every two quarts of cream will make about a pound of butter. When the butter has "come"—or when the fat in the cream has been separated from the liquid—the buttermilk is drained off, and the butter is washed in cold water. Then it is kneaded and "worked," to get the water out, and salt is added, unless "sweet butter" is desired. Of the two, sweet butter is considered the greater delicacy and brings a higher price, but it does not keep so long. Coloring matter is usually added, too, for butter, especially in winter, is usually a very pale yellow.

A large part of the milk produced in the United States goes to the making of butter; and though we export some butter, we import still more than we send away. For the people of the United States eat, as a rule, more butter than most of the other nations do—which is a very good thing, for it is one of our best foods, rich in vitamins and very nourishing. Growing children should eat all they can of it.

Here in the butter print room of a large Minnesota creamery, conveyors are feeding 64-pound chunks of butter, already inspected and graded, to machines which will cut, wrap, and package it for sale. Such a process keeps the butter clean and pure, for a human hand never touches it.

Courtesy Land O Lakes Creamery, Inc. Minneapolis, Minnesota

Reading Unit No. 5

THE STORY OF CHEESE

Note: For basic information not found on this page, consult the general Index, Vol. 15.

For statistical and current facts, consult the Richards Year Book Index.

Interesting Facts Explained

How cheese was probably invented, 9–345
What rennet is, 9–345-46
How cheese is made in large quantities, 9–344, 346, 347
Cheese "ripening," 9–347
Why cheese is good for us, 9–347
The different kinds of cheese and their places of manufacture, 9–348

Things to Think About

What does rennet do to whole milk?
How is a curd made hard?
Why are cheeses ripened?
Why are there many different kinds of cheese?
Why is cheese good to eat?
Where do the popular cheeses come from?
Would Americans be better off if they ate more cheese?

Picture Hunt

From what animal does milk for Swiss cheese come? 9–345
What steps are followed in making Cheddar, or "American," cheese? 9–344
How are finished cheeses tested? 9–347

Related Material

What are bacteria? 2–12-21
How many pounds of cheese are made in the United States each year? 9–338
What is Holland famous for? 6–351
In what kind of surroundings is Swiss cheese made? 6–249

Leisure-time Activities

PROJECT NO. 1: To learn the action of rennet, get some junket tablets, which contain rennet, and add one to a glass of milk. Stir the milk for a moment. What is the solid part called? Place the mass in a handkerchief and squeeze out the whey, 9–345-46.

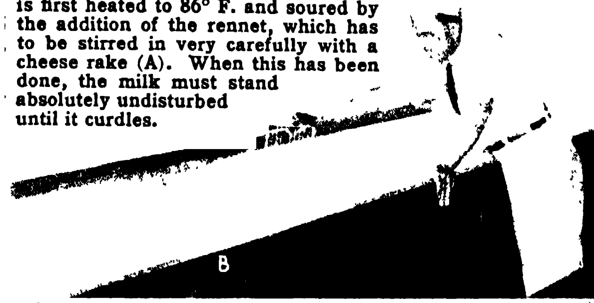
PROJECT NO. 2: Visit a dairy or a cheese-making plant, 9–344

PROJECT NO. 3: Learn by tasting and smelling them, the different cheeses, 9–348.

Summary Statement

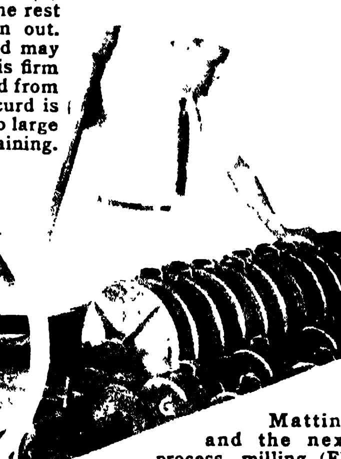
Cheese making is a fine art. The milk is curdled by rennet, and the curd is flavored with the products of bacteria or molds. Cheese is a nutritious food because it contains fats, proteins, vitamins, and minerals.

The pictures on this page show the most important steps in making Cheddar, or "American," cheese. The milk is first heated to 86° F. and soured by the addition of the rennet, which has to be stirred in very carefully with a cheese rake (A). When this has been done, the milk must stand absolutely undisturbed until it curdles.



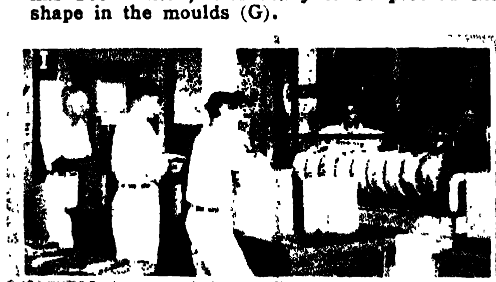
Half or three-quarters of an hour after the rennet is added, the curd is firm and ready to be cut into little cubes with a curd knife (B). Then more heat is applied, and there is more stirring, until the whey is loosened enough to be drained off.

Next the curd is ditched (C) --raked up to allow the rest of the whey to drain out. D shows how the curd may be tested to see if it is firm enough to be separated from the whey. At E the curd is being matted—cut into large pieces for further draining.



Matting and the next process, milling (F), are the steps peculiar to this kind of cheese. The milling, as you can see in the picture, breaks up the curd into tiny pieces. Now, after it has been salted, it is ready to be pressed into shape in the moulds (G).

Cheddar does not ripen so long as most cheeses, but it does spend a week or two in the curing room (H), where it is kept at a cool, even temperature and turned every day, until it is finally covered with paraffin. The men at I are paraffining the cheeses and packing them for shipment.



Photos by U. S. Department of Agriculture, and the Kraft Cheese Co.

Photo by Swiss Federal Railways

Every spring, from many Swiss villages, the cattle are driven to the rich pastures high in the dizzy Alps. With them go men to herd them; and often enough whole families or groups of families spend the summer in some picturesque chalet (shă'lĕ') such as this one, shut away from the noisy world, guarding their herds. Then when the tang in the air warns them that autumn is coming, they bring their charges home again for the winter. These are the cows from whose milk the real Swiss cheese is made; it is marked "Switzerland" to show that it actually comes from there, for the same variety may be made in other countries.

THE STORY *of* CHEESE

This Story Will Tell about the Art and Science Which Go into Making a Food That Is Richer than Any Meat

MEN could not help inventing cheese. There was the milk, which nothing could keep from souring in those good old days when ice was seen only in winter and no one knew how to sterilize a jar or bowl in order to keep it clean. And there was the curd that formed after the milk had soured. Surely it was too precious to be thrown away. At first it doubtless was eaten raw—just to save it. But it was not a very appetizing dish, and little by little the painstaking housewives—or perhaps "tent wives" would be the better word, since men at that time must have led a roving life, tending their flocks and herds—the painstaking wives and mothers learned to press the water, or "whey," out of the thickening curd and to make the cheesy part into quite a pleasant dish. And from that far-off beginning, long before the dawn of history, there gradually grew up all our varied processes for making cheese. They must have been fairly well developed long before anyone thought of making butter.

The story goes that long, long ago a traveler starting out on a journey, in the days when any liquid had to be carried in a bag made out of skin, once put a small quantity of fresh milk into a cow's stomach, and took it with him to quench his thirst on the way. On the whole it made rather a neat container, and he probably expected that the milk would keep sweet at least for a day. Imagine his surprise, then, when he went to take a sip, to find that the contents of the bag had turned into thick curd.

Now we have no way of knowing whether the story is true or not, but surely the discovery of "rennet" must have come about in some such way. For if the traveler's

bag had been made out of a cow's fourth stomach—and all cows have that many—it would have contained in its lining an acid that curdles milk very rapidly. Nowadays we extract this acid, called "rennet," from the stomach of a calf, and use it to form the curd in the milk that is to be made into cheese. Indeed, the acid is to cheese making about what yeast is to bread making. It is used for every kind of cheese except the "cottage cheese" which we make at home. This is nothing but the pure curd with a little cream added.

Now during all the centuries from that far-off time when "cheese" was first invented until the middle of the last century, all the cheese that was eaten was made at home. And many were the kinds that were invented. Every country, every district, one might almost say every town, had its own especial style of cheese. Many of these were a good deal alike, and many were pretty poor and have not come down to our own day. But the better kinds were made with ever-increasing care, and even to-day the famous dairies of Switzerland and Germany and Holland are tended by spotless dairymaids who give to the making of their precious cheeses all the skill and pains that their grandmothers and great-grandmothers have given for centuries past. The choicest cheeses in the world are still often made by hand, to the tune of the whirring windmill and the clump of wooden shoes.

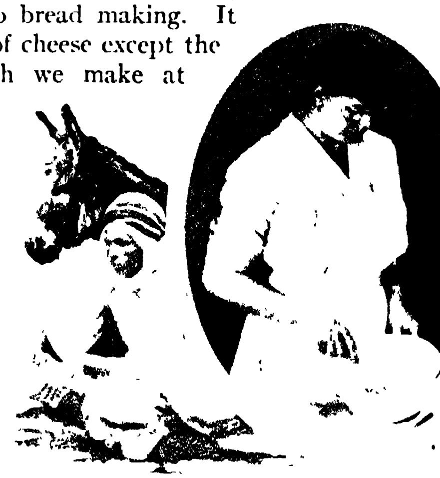


Photo by U. S Department of Agriculture

"Cottage cheese" was probably the first cheese ever made, and many of us, like this good cook, still think it decidedly worth making. As for the little donkey and its master, perhaps they are the first pair who made cheese with rennet—the man by putting milk in a cow's stomach, and the donkey by carrying the sack slung over his sturdy neck!

What Is American Cheese?

But after 1850 cheese factories began to spring up in this country everywhere, and eventually the farmer's wife turned that branch of her toil over to the machines. Much of the cheese that our factories turn out is like the English Cheddar cheese, which has been made near that old English town for centuries. But we call it "American" cheese because for so long it was about the only kind one could buy here.

Tiny Plants That Make Our Cheese

It is fairly simple to make. When the milk comes into the cheese factory it is weighed and put into the cheese vat, a large oblong tank sitting inside a still larger tank that is kept partly full of warm water. The warm water around it keeps the milk at a temperature of about 86° Fahrenheit. To this warm milk tiny little plants called lactic acid bacteria (băk-tē'-rĭ-ȧ) are added. They are too small to be seen with the naked eye, but as they grow rapidly and multiply they turn the milk sour. If the cheese is to be a rich yellow, a vegetable coloring matter is added, too.

Then the rennet is put in—about three ounces to a thousand pounds of milk. Under its powerful action a thick curd has formed at the end of only thirty or forty minutes—you know how long it takes the curd to form in milk that is standing in the refrigerator. The curd is cut up into small pieces, the whey is drained off, and the whole mass is allowed to cook for some half hour or more in a temperature of about 95° F. Again and again the curd is cut and turned and stirred to get the whey out, and when it is fairly well drained it is put through a milling machine that breaks it up into small particles.

Now is the time to add the salt—some two or three pounds for every hundred pounds of curd. When the salt is thoroughly mixed with the curd, the whole mass is left to cool until it has a temperature of about 80° Fahrenheit. Then it is ready to be wrapped in cheesecloth and go into the "hoops," or moulds, in which it is pressed

into shape by hydraulic power—that is, power supplied by a heavy pressure of water—though in some small factories a hand press may still be used. These moulds are of a good many shapes and sizes, and are known as prints, twins, flats, longhorns, and young Americas, but the cheese that goes into them is all alike.

Eighteen hours in the press will set the cheese into its permanent shape and press out most of the moisture. Then begins the "ripening," one of the most important stages of all. For it, the cheese is taken out of the press and stored in the curing room, where at first it must be turned every day, and later once a week. When it is thoroughly ripened, and all the little plant organisms, such as bacteria and various kinds of mould, have done their work, it has developed the rich tang that marks the really good cheese. An underripe cheese is always flat and tasteless. The famous Stilton cheese that comes from England is allowed to ripen for two years.

Photo by Kraft Cheese Co

Not all the care in the world will make every cheese come out tasting like every other cheese. So a sampler goes about among the cheeses and plugs them as one might a watermelon, to discover how good each is and how sharp it tastes.

Four Hundred Kinds of Cheese

Now all of the various cheeses—and there are some four hundred kinds—may be classed in eighteen general types, and these in turn fall into a few larger classifications. For instance cheese is "hard" or "soft," according to the amount of water it contains and the way it is ripened. It may be made of skimmed milk, whole milk, or even have extra cream added, or it may contain the milk of cows or goats or sheep. It may be seasoned with pimentoes or various herbs, or it may owe its flavor to moulds of different sorts that grow in it as it ripens. But it is only since scientists have been at work on the subject that cheese of any single kind can be turned out uniformly excellent every time, for all sorts of slight variations in making, and especially in ripening, will change the flavor.

We in the United States have been very slow to learn what a valuable food cheese is. Other countries are far ahead of us in that. In Switzerland every person eats, on an average, some twenty-four pounds of cheese a year; in France the average is about fourteen pounds, but in the United States the average consumption is much smaller. Yet cheese is more than twice as nourishing as an equal weight of beef, for it is highly concentrated. It contains valuable fats and protein (prō'tē-ĭn), which is necessary for growth and for repairing our bodies. The protein in milk or cheese is in the form of a substance known as casein (kā'sē-ĭn). Cheese is rich in vitamins and calcium, and is easily digested.

So our use of cheese is growing. We are learning to make a good many of the choice foreign kinds, and altogether turn out hundreds of millions of pounds a year. We eat just about all of this, and then import a good deal besides. Wisconsin leads in the industry. She manufactures enormous quantities and a large variety, and Sheboygan, on Lake Michigan, handles more cheese than any other city in the world. New York comes next as a cheese-producing state, and Oregon third. New Zealand exports more cheese than any country in the world, and Holland and Canada come second and third.

How romantic the roll of those old cheeses sounds! The names are the names of places whose inhabitants had the ingenuity to turn out a perfect product, sometimes centuries

ago. France has given us the racy Roquefort (rôk'fôr'), made of sheep's milk and ripened in natural caves near the town for which it is named. It is rather hard, and is mottled, almost like marble, with a blue-green mould. From France, too, comes Brie (brē), a soft white cream cheese with a pronounced odor and sharp taste. Camembert (kȧ'môN'bâr'), a division of France, gave its name to a rich, buttery cheese, which we have now learned to make in this country by adding the imported mould to the cheese during the making. And Neufchâtel (nû'shȧ'tĕl'), a heavy, rich cheese put up in little cylindrical moulds only some three inches long, has about the consistency of Camembert.

Switzerland has given us some of our most popular kinds, such as the well-known "Swiss cheese," or Emmenthaler (ĕm'ĕn-tä-lẽr), which was made in the Emmenthal Valley, near Berne, all of five hundred years ago. It is very much like "American" cheese in consistency, but is a very light yellow and is honeycombed with holes, which are caused by bacteria during the ripening. Gruyère (grü'yâr') is another Swiss cheese very much like Emmenthaler. These varieties are now made in all parts of the world.

The rich Gorgonzola (gôr'gŏn-zō'lȧ) was first made in Italy, in a little village near Milan. It is much like Roquefort, but has a green and red mould. Parmesan (pär'mē-zăn'), too, comes from Italy, and takes its name from Parma. It is hard and greenish, with a pronounced taste, and is used for grating into soup or over macaroni. Only skim milk goes to its making.

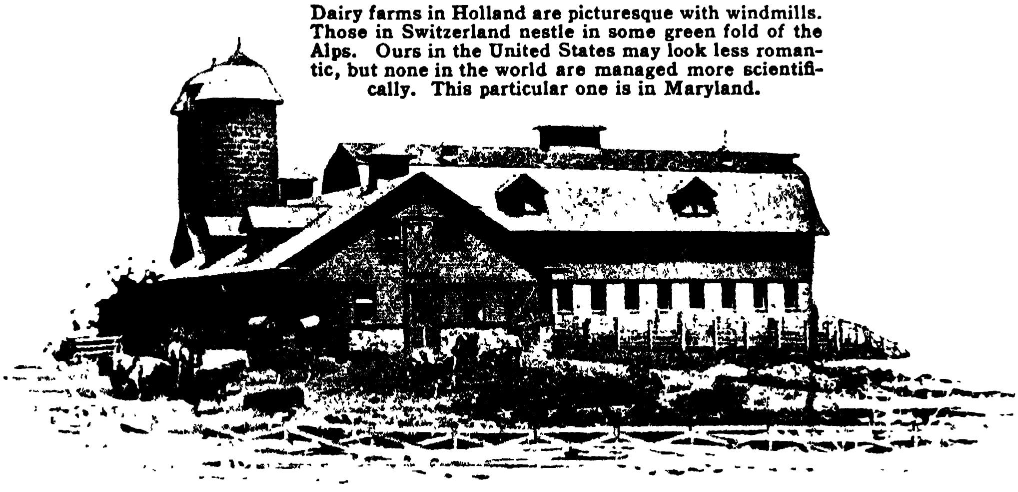
Holland is known for its Edam, a hard, orange-colored cheese dyed red on the outside. It has a mild flavor.

From the town of Limburg, in Belgium, the odorous Limburger takes its name. It is made in the form of a brick from whole milk, and requires great skill in the making. The body of the cheese, inside the yellowish or reddish-brown rind, is white and very creamy, but you must eat it quickly, for if you get a whiff of it your appetite for it will be gone. The unpleasant odor comes during its two months of ripening in very moist rooms.

Brick and Muenster (mün'stẽr) cheese, from Germany, are somewhat like Limburger, and are made in much the same way.

England has had a number of famous cheeses—the popular Cheddar; the brownish Cheshire, with its greenish mould; and best of all, the kingly Stilton, the only "double cream" cheese there is, for to the whole milk from which it is made a double portion of cream is added. The result is a hard, strong cheese, very rich and streaked with a heavy mould. It should ripen for at least two years.

Our own "process" cheeses are made by reworking inferior cheese. What we call "blue cheese" is much like Roquefort.



Dairy farms in Holland are picturesque with windmills. Those in Switzerland nestle in some green fold of the Alps. Ours in the United States may look less romantic, but none in the world are managed more scientifically. This particular one is in Maryland.

Reading Unit No. 6

SIXTY BILLION EGGS A YEAR

Note: For basic information not found on this page, consult the general Index, Vol. 15.

For statistical and current facts, consult the Richards Year Book Index.

Interesting Facts Explained

Things to Think About

What might happen to a wild bird which cackles after laying an egg?
What kind of food is given to chickens?
Why do modern chickens lay many more eggs than their ancestors did?
How are hens made to lay eggs all the year round?
How are eggs hatched scientifically?
What happens inside an egg when a baby chick forms?
Why do we rely on chickens for our eggs, instead of on ducks or geese?
Why do we powder eggs?

Picture Hunt

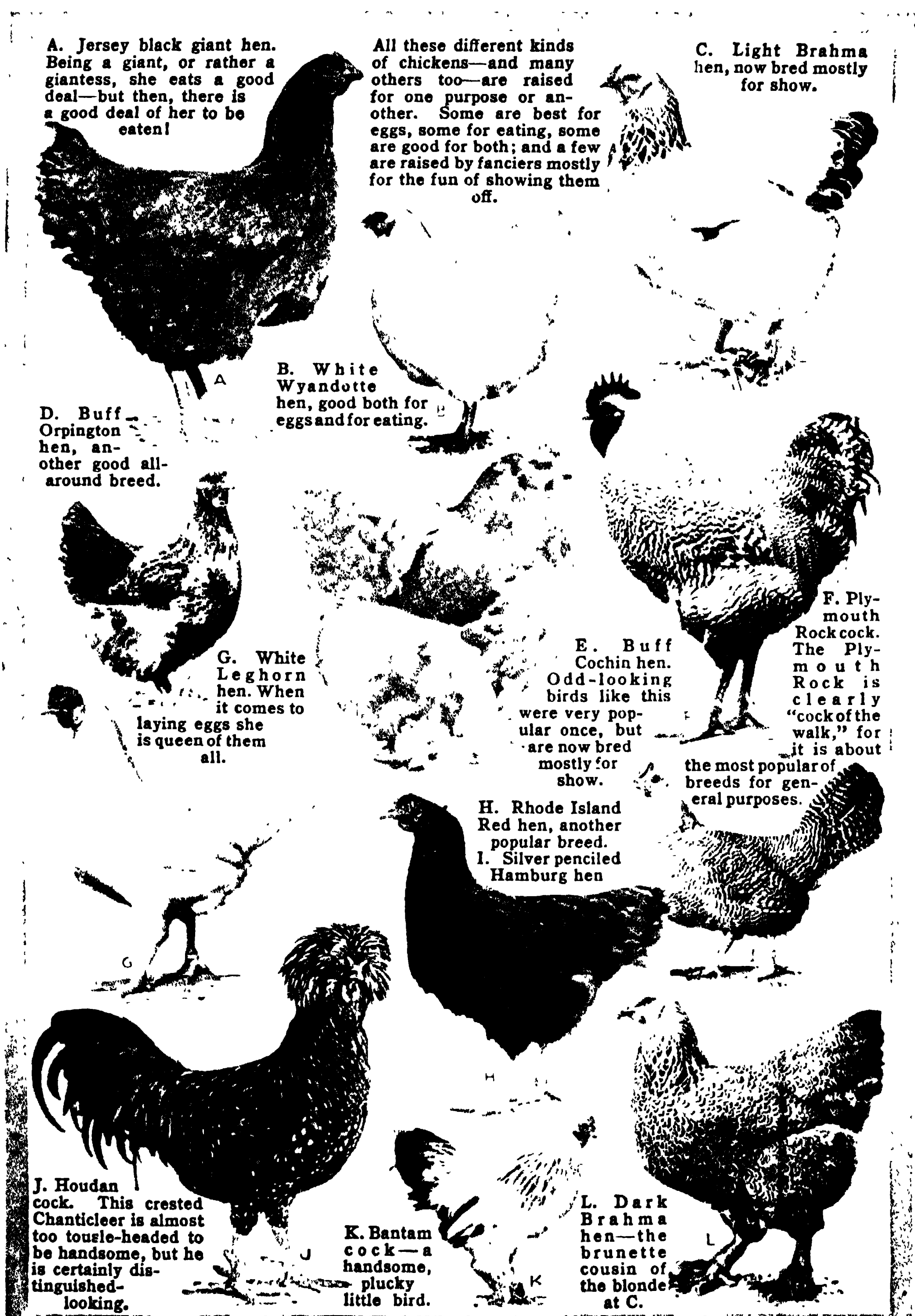
What "royal sport" once depended on poultry? 9-352
Which of the birds in the picture are raised for food, eggs, or beauty? 9-353
How did the turkey get its name? 9-355
How can an incubator hatch 16,000 eggs at once? 9-356
What kind of hens lay most eggs? 9-350
How are some eggs preserved? 9-357

Leisure-time Activities

PROJECT NO. 1: Test a number of eggs for freshness, 1-473.
PROJECT NO. 2: Visit a large poultry plant and learn how poultry are fed, cleaned, and bred, 9-356-58.
PROJECT NO. 3: Get fertilized eggs of different ages from a farmer and open them to learn how chicks develop, 9-356.

Summary Statement

We raise chickens chiefly for eggs and meat. If we remove the eggs as they are laid, the hen continues to lay more. Night lighting, rich foods, cleanliness, and selective breeding increase the number of eggs laid by the hen.



All these different kinds of chickens—and many others too—are raised for one purpose or another. Some are best for eggs, some for eating, some are good for both; and a few are raised by fanciers mostly for the fun of showing them off.

A. Jersey black giant hen. Being a giant, or rather a giantess, she eats a good deal—but then, there is a good deal of her to be eaten!

B. White Wyandotte hen, good both for eggs and for eating.

C. Light Brahma hen, now bred mostly for show.

D. Buff Orpington hen, another good all-around breed.

E. Buff Cochin hen. Odd-looking birds like this were very popular once, but are now bred mostly for show.

F. Plymouth Rock cock. The Plymouth Rock is clearly "cock of the walk," for it is about the most popular of breeds for general purposes.

G. White Leghorn hen. When it comes to laying eggs she is queen of them all.

H. Rhode Island Red hen, another popular breed.

I. Silver penciled Hamburg hen

J. Houdan cock. This crested Chanticleer is almost too tousle-headed to be handsome, but he is certainly distinguished-looking.

K. Bantam cock—a handsome, plucky little bird.

L. Dark Brahma hen—the brunette cousin of the blonde at C.

Photo by U. S. Department of Agriculture

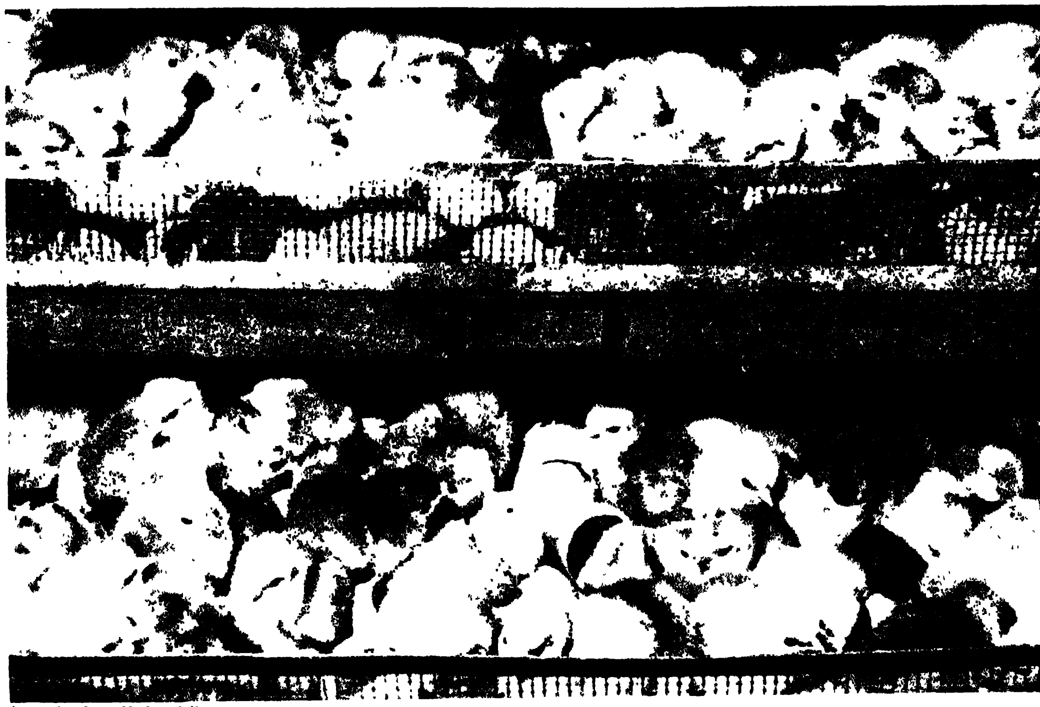


Photo by John H. Vondell

This incubator has kept our newly hatched chicks comfortably warm while they were in the shell. Now a "brooder" will do duty in place of their mother's wings. But it will soothe them with no reassuring cluck. The cautious fellow at the right of the lower tray—as if realizing that he is now on his own—seems to be making a last check of his old house to be sure that nothing has been left behind.

SIXTY BILLION EGGS A YEAR

That Is the Number That Our Hens Produced in a Single Year during the Second World War

EVERY time a hen has laid an egg she breaks out into a cackle. Now why in the world does she do that?

She surely has no business doing it. If she were wild, as all hens used to be, the noise would tell any of her enemies that love to eat her eggs just where to look for them; and it is against all the ways of nature for a mother to tell her enemies where to find her babies. The other birds do not do it. Is the hen a little too happy to keep still, or does she feel a certain sort of pride in her feat and have to tell the world? Nobody knows. Probably the hen does not know either. At any rate she cannot tell.

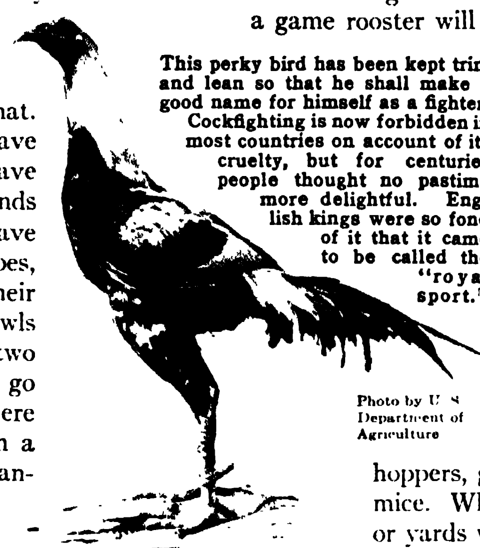
What we do know is that in the United States alone the hens cackled nearly sixty billion times in a single year. This means that we got nearly sixty billion eggs. These were worth about one and a half billion dollars—more than the value of all our wheat crop, even though we grow a large part of the wheat of the world. So the hen and her eggs are worth a story.

As we have said, she was once a wild creature. But we think we know where she came from. In the southeastern part of Asia there were two kinds of wild bird that seem to have been tamed very long ago—the red jungle fowl and the azeel. One of these was the parent of our chickens, or perhaps both of them; for they may well have been crossed after they were tamed, to form our hens.

They may have first been tamed for the cruel sport of cockfighting, now happily

forbidden by the law. But very soon the value of their eggs must have been seen. And ever since then they have been carefully bred, all down through the ages, to make them larger and better to eat, and especially to make them lay bigger eggs and far more of them.

In China there is a written record telling how chickens were brought into that country "from the west" about thirty-three hundred years ago. They probably came in from India, where they must have been raised long before that.



This perky bird has been kept trim and lean so that he shall make a good name for himself as a fighter. Cockfighting is now forbidden in most countries on account of its cruelty, but for centuries people thought no pastime more delightful. English kings were so fond of it that it came to be called the "royal sport."

Photo by U. S. Department of Agriculture

In all the breeding we have done since that day we have created many different kinds of chickens. We now have them in various sizes, shapes, and colors, all good in their various ways. We have fowls that weigh less than two pounds, and others that go over fifteen. In Japan there is a Yokohama fowl with a tail twenty feet long, and another fowl without any tail at all. Some of our own fowls have large, feathery crests on their heads, and others have no feathers at all on their necks, which are as bare as a turkey's. Most of our fowls have four toes, but the English Dorking and the French Houdan rejoice in five. And the various kinds are different in many other ways.

The Crop, the Comb, and the Wattles

But in many ways they are all alike. They all have strong, pointed beaks and a large gullet, called a "crop," for storing food. They have pretty weak wings and are poor flyers; but they have stout legs and toes, for running, scratching, and perching. The males have a sort of extra toe in the sharp spur on their legs, which they use in fighting. Both the males and females have a fleshy growth on top of their heads, called a "comb," and two others under the chin, called "wattles." These are larger in the male, and they come in many shapes. The comb is sometimes very small and sometimes very large, according to the kind of fowl; and sometimes it is single, sometimes double. In their various shapes, combs are known as pea, rose, buttercup, walnut, strawberry, or V-shaped.

Brave but Stupid

The chickens are all rather stupid animals, far less clever than the crows and many other birds. But they do not lack in bravery. A hen will fight boldly to save her chicks, and a game rooster will put up as brave a fight as any animal we know. But they are foolish enough to gobble salty food if they can get it, although salt means death to them.

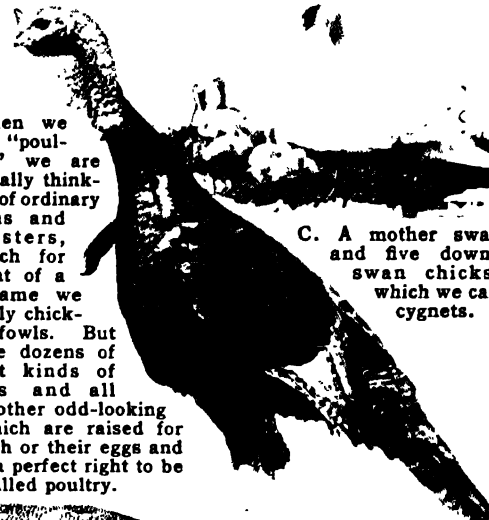
They will eat both animals and vegetables. If we let them range in summer they will live on grains and seeds, and on flies, beetles, worms, grasshoppers, grubs, or even frogs and mice. When we keep them in pens or yards we ought to give them a similar variety of food. A good thing for them is a mash made out of ground grain, chopped meat, and chopped fresh vegetables. Feeding the chickens is a science, for the eggs they lay depend largely on the food they eat.

In all we have produced more than a hundred different kinds of chickens. Of these there are four main classes—the Asiatic, best for eating, the Mediterranean, best for laying eggs, the American, good for both purposes, and the fancy breeds, like the little bantams, kept for pets or curiosities. But some of the last are also good layers and make a good meal.

Do You Know All These Chickens?

And now if you will turn to the pictures you will see a few of the many kinds in these four classes. Some of them will be old friends, but others may look rather strange. In the Asiatic class you will find the Brahmas, Cochins, Langshans; in the Mediterranean the Leghorns, the Minorcas, and

POULTRY AND EGGS



When we say "poultry" we are usually thinking of ordinary hens and roosters, which for want of a better name we call simply chickens or fowls. But there are dozens of different kinds of chickens and all sorts of other odd-looking birds which are raised for their flesh or their eggs and so have a perfect right to be called poultry.

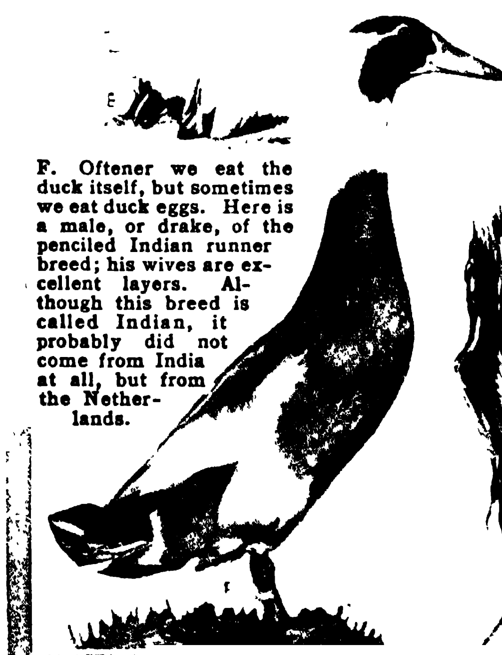
A. This rooster is a fine specimen of the popular Plymouth Rock breed.

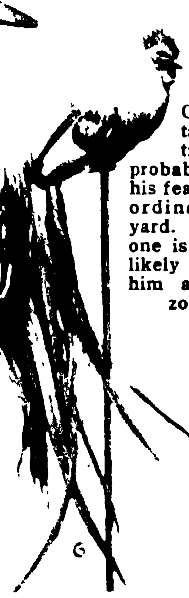
C. A mother swan and five downy swan chicks, which we call cygnets.

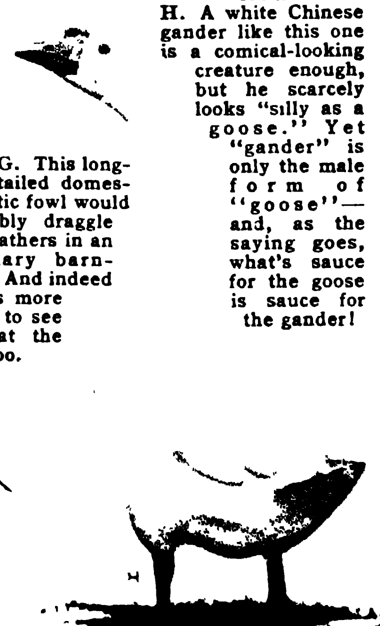
B. This turkey gobbler looks rather worried. Perhaps it is almost Thanksgiving time!

D. Guinea fowls are not the handsomest of birds, but they are very good to eat. Here is a pearl guinea cock.

E. This black-tailed Japanese bantam rooster is small but uncommonly handsome.







H. A white Chinese gander like this one is a comical-looking creature enough, but he scarcely looks "silly as a goose." Yet "gander" is only the male form of "goose"—and, as the saying goes, what's sauce for the goose is sauce for the gander!

F. Oftener we eat the duck itself, but sometimes we eat duck eggs. Here is a male, or drake, of the penciled Indian runner breed; his wives are excellent layers. Although this breed is called Indian, it probably did not come from India at all, but from the Netherlands.

G. This long-tailed domestic fowl would probably draggle his feathers in an ordinary barnyard. And indeed one is more likely to see him at the zoo.

Photos by U. S. Department of Agriculture and N. Y. Zoo

others; and in the American the popular Plymouth Rocks, Wyandottes, and Rhode Island Reds.

A hen does not live very long. She gives us eggs for only four or five years. The men who raise chickens have to replace about half their flock every year. The hens begin to lay when they are from five to eight months old, and the best layers begin the earliest.

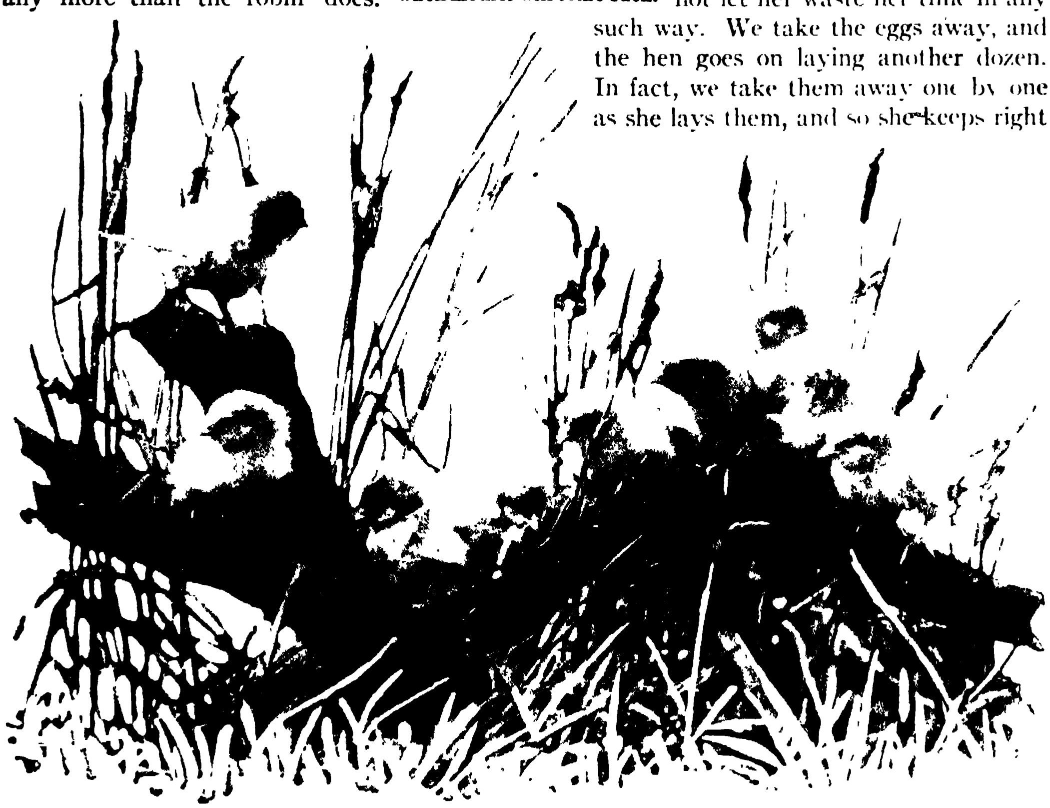
If you just give a hen her own way, you will never get any eggs at all. In the spring she will lay a few eggs, just like any other bird—never more than one a day, and rarely more than fifteen in all. Then she will stop. She will start "setting" on the eggs, and will stay on the nest for the next three weeks until her chicks are hatched. She must now tend the chicks for a good many weeks more. And when she weans them she will not lay any more eggs or hatch any more chicks till next spring. So there will be no eggs for you and me. The hen never meant her eggs for you and me, any more than the robin does.

What we have to do is to "fool" the hen into laying far more eggs than she would if we let her alone. We "fool" our oranges into growing without any seeds, and we "fool" our hens into making far more seeds, or eggs, than they need for their own purposes.

How to Breed Good Chickens

First, of course, we pick out the hens that lay the most eggs. Then we hatch chickens from the eggs of these hens. Many of these chickens will be like their mother. They will lay more eggs than other chickens. But we pick out the best of them, and hatch more chickens; then pick out the best of these, and hatch still more chickens, and so on. This we have been doing for thousands of years, and the result is that we have many kinds of hens that would astonish their first wild parents with the eggs they lay.

Then when the hen has laid a dozen or so eggs and is all ready to start "setting" on them, we do not let her waste her time in any such way. We take the eggs away, and the hen goes on laying another dozen. In fact, we take them away one by one as she lays them, and so she keeps right



These baby chicks are still feeling a little strange in the big world. Perhaps they are huddling together wondering when mother will come back.

Photo by Field Museum

Long before the white men came to America wild turkeys such as these were hunted by the Indians, and in Mexico and South America some of them had been domesticated, or tamed. At first the Europeans confused this American fowl with another which had come into Europe by way of Turkey—hence its name.

on laying. Of course she thinks that some time she will have enough to set on!

But that is by no means all we do. We have found out that a great deal of food, and certain kinds of food, will make for more eggs. So we give the hens plenty to eat, and of the right things. In the winter, when they never lay at all if let alone, we light up their coops early in the morning and late in the evening. This "fools" them into acting as if every day in the year were summer. In the longer light they eat more, and that means more eggs.

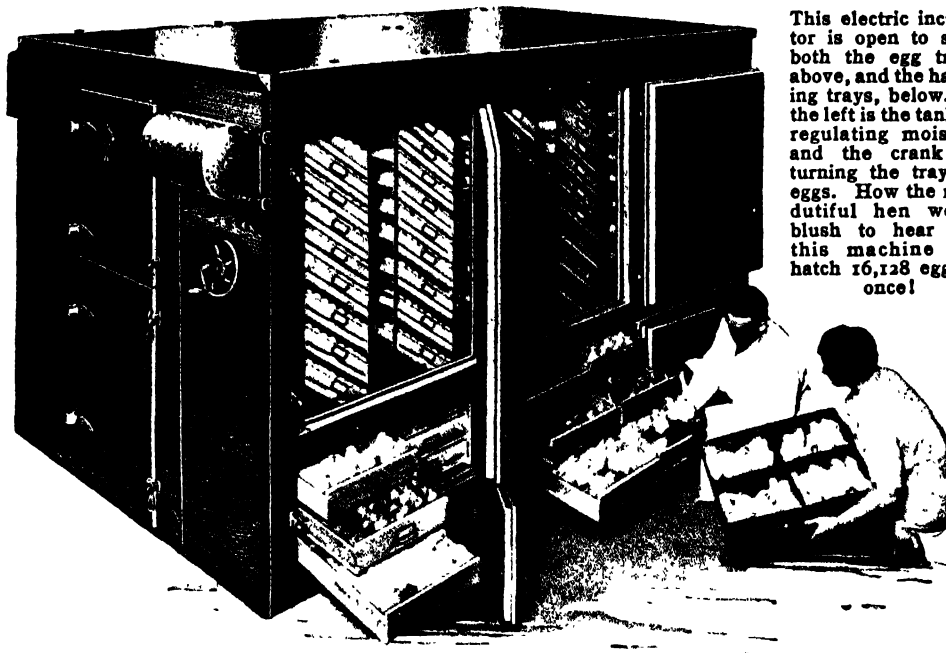
By these tricks and many others we make the good ones keep on laying all the year. Indeed we have done wonders. Only a few years ago a common hen would not lay more than six dozen eggs a year, but now there are many that will give us two hundred, while the prize winners do far better still. There was a hen in New Zealand that laid 361 eggs in 364 days. She took off only four days in the year!

The writer of these lines used to raise chickens when he was a boy down in "ole Virginia," and he had a right to be proud of his Wyandottes. But if one of them had ever laid like that, he would have thought the age of miracles was born again in Dixie.

Out of fifty winners in a series of prize contests for egg laying, all but six hens were White Leghorns. Three were Barred Plymouth Rocks, two were Wyandottes, and one was a Rhode Island Red.

But if we do not let the hens hatch their own chicks, how do we get the chicks? That is really a very simple matter, though we have to be careful about it.

All we have to do is to keep the eggs fairly warm, to turn them over twice a day for the first week or so, and to let them have enough fresh, moist air. The hen showed us how to do all this. She keeps them at a temperature of 103°, for her blood, like every bird's, is a good deal warmer than ours. She also turns them over. On many a small farm she is still allowed to do this every so often. But on the great poultry farms we do it for her. We simply do what she does for about three weeks, and then we have the chicks. The machine in which we hatch them is an incubator (ĭn′kû-bā′tẽr), and



This electric incubator is open to show both the egg trays, above, and the hatching trays, below. At the left is the tank for regulating moisture and the crank for turning the trays of eggs. How the most dutiful hen would blush to hear that this machine can hatch 16,128 eggs at once!

Photo by U S Department of Agriculture

with it we can hatch hundreds and thousands of chicks at once.

What goes on in an egg when it is turning to a chick? That is Nature's secret, one that man has never managed to find out. It is one of her million marvels, happening every day, and past all our understanding. It is the birth of a life. And life, whatever it may be, is the most mysterious thing that is all around us all the time. The dead stuff in the soil rises up in the sap of a tree and turns into life. The little germ in the egg nestles in the warmth for three weeks and turns into a thing that can scratch and run and fly—and lay more eggs!

The Beginning of a Baby Chick

But if we know nothing about what life is, we can still say how it grows up in the eggshell.

If you open a fresh egg you will find a yolk at the center and white all around it, covered by a very thin skin just under the shell. You will also find a little germ in every fertile egg—a small, jellylike thing on the yolk and about the same color as the white. That little germ is what is going to turn into the chick. The yolk and the white—also called albumen (ăl-bū'mĕn)—are only the food it will live on while it is still growing in the shell.

You will also find a hollow space at the big end of the egg. That is full of the air that the chick will need to breathe before it comes out of the shell. And as for water, the yolk and the white have enough of that to last.

The Birth of a Baby Chick

After only a few hours of warmth the little germ begins to change its shape. It turns into something like a pear. In two days it will have a heart and a few blood vessels. By the end of three days the brain and lungs and eyes and liver, with some other organs, have begun to form. Then the wings and legs are started in tiny buds, and the nose and ears. In one week the thing begins to look like a bird—though its head is a good deal too big for the rest of it. After this it grows rapidly, and the yolk and white keep disappearing. At last it is ready to break open its shell with its tiny beak and step out into the wide world—and a prettier little yellow thing was never made!

All that is Nature's secret, and we may never find it out. We can work the charm only by doing just as Nature tells us. But

we have been working it for many a hundred years. The Egyptians and the Chinese knew how to do it centuries ago. The Chinese sometimes put the eggs in a basket and cover them with manure. As the manure ferments, or "works," it makes a little heat —enough to hatch the eggs. The Egyptians have earthen hatching ovens and burn a little straw or some such thing beneath them. They still hatch millions of eggs in this way every year.

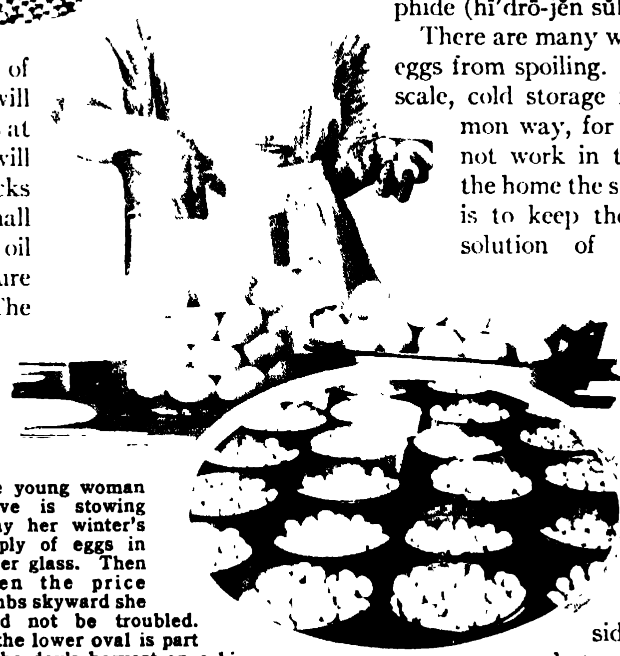
Our own incubators are of all sizes. Some of them will take only a few dozen eggs at once. The giant ones will hatch fifteen thousand chicks every three weeks. The small ones are heated with oil lamps, and the temperature is regulated by hand. The big ones are warmed with hot water from the kind of furnace that we use to heat our houses; and in these the heat is regulated by a thermostat, which turns it on or off as needed.

Millions of the baby chicks are packed in light boxes when they are only one day old, and shipped off to the farmers who want them. Sometimes they even travel for long distances to get to the place where they are going to grow up. They never have a mother to scratch for them and cluck to them, but it seems to be all the same to them.

A great many of these chicks never live to lay eggs. They appear upon our tables instead. For both chickens and eggs are still rapidly increasing on the table. There is no better food than eggs; for Nature made them to bring up her chicks on for the first three weeks of life, and she put into them all the things the body needs.

Of course eggs may spoil, like all other kinds of fresh food. The reason is the same as for all the other foods. The shell of an egg is porous, and will let in bacteria (băk-tē′rĭ-à)—or very tiny plants—that grow and multiply on the rich food within. They "rot" the egg. The foul odor that it then has is caused by a gas produced in it called hydrogen sulphide (hī′drô-jĕn sŭl′fīd).

Since eggs keep fresh and edible much longer if they are protected from heat, careful shippers and packers try their best to keep them cool. Here are dozens laid out in a chilling room.



The young woman above is stowing away her winter's supply of eggs in water glass. Then when the price climbs skyward she need not be troubled. In the lower oval is part of the day's harvest on a big California poultry farm. Many a breakfast table will be merrier because of it!

There are many ways to keep eggs from spoiling. On a large scale, cold storage is the common way, for bacteria do not work in the cold. In the home the simplest way is to keep the eggs in a solution of water and liquid glass. This does not let in the bacteria.

There are a number of other tame birds besides chickens that we keep for their eggs and meat —ducks, geese, turkeys, guinea fowls, and others. We have talked most about the chickens because they are by far the most important. They make up by far the greater part of all our poultry.

The ducks and geese are water birds in origin, and they still show it. They were both tamed long before the days when history begins. There are many kinds of tame ducks, all but one of them descended from

Photo by the Colorado Association

The modern poultry farm is a clean and attractive place, not at all like the stuffy, smelly chicken house some of us can remember. Here a whole bevy of Chanticleers and their prosperous-looking wives are scampering about in the sunshine or picking at the carefully prepared and balanced meals the poultry raiser provides for them. If after the mating season is over, the owner will give Chanticleer a runway of his own, the hens will lay better eggs—eggs that are in no danger of hatching into chickens and so will keep fresh much longer, even in warm weather. Our government urges the spread of this information.

the mallard that we still hunt in his wild state. The one exception is the Muscovy duck, which comes from Brazil.

Ducks will lay more eggs than hens, surprising as the fact may seem. A prize duck in New Zealand laid 363 eggs in 365 days—taking only two days off. And the duck egg is larger.

Where People Use Duck Eggs

In Europe the great places for ducks are Holland and Belgium, and the eggs are largely used in the Dutch bakeries. There are many ducks in China and Australia. In America there are more in New York than in any other state.

The goose has long been called a very silly bird, though no one knows exactly why—perhaps because he follows you and hisses so loud. At any rate he is good eating, like the duck, and is most popular around Christmas and New Year's. His liver has long been a delicacy. The old Romans used to overfeed their geese to swell their livers, and we do the same thing in many a land to this day.

Goose feathers have long been used for pillows and cushions, and for centuries goose quills were used for pens—as they still are in some few old-fashioned places. The Declaration of Independence was written with a goose quill.

Geese will flock together just like sheep, and in many parts of Europe they are herded in about the same way. In some villages the small flocks are sent out every day under a single person who herds them all day long and brings each flock back to the owner at night. The Germans raise and eat more geese than any other people.

The Largest Game Bird in the World

The turkey is a native of America. In his wild state he is the largest game bird in the world, and it takes a clever hunter to get him. But he had been tamed by some of the natives before Columbus came here.

A turkey has no feathers on his head or the upper part of his neck. There is a fingerlike piece of skin on the top of his head that grows longer and redder as the gobbler struts around, with his tail feathers lifted and spread out as if he were a peacock. There is also a curious hairlike growth on the breast of the males that looks like a beard.

We eat turkey at any time, but always on Thanksgiving Day. We should eat it much oftener if it were cheaper, for it is tender and has a fine flavor. But turkeys are hard to raise, and the meat is therefore rather costly.

There are small flocks of turkeys on the farms in most parts of America, and many large "turkey ranches" in Texas, Oklahoma, California, Colorado, Utah, and Nevada. Texas alone raises millions of the big birds every year. And yet Americans love turkey so much that they buy a great many from Ireland, Russia, Austria, and Argentina.

Even more expensive, but very delicious and served often at dinner parties, is squab, or young pigeon. It is about four weeks old, weighs three-quarters of a pound, and is tender and plump.

Guinea (gĭn′ĭ) fowls came to us from Western Africa. They were known to the Romans two thousand years ago, but for some reason they died out in Europe after the Roman days, and were not brought in from Africa again until about four hundred years ago. Their eggs are too small to be of much use, but their flesh is of the finest quality and is very highly prized.

The Vanity of the Peacock

If the goose has long been called silly, the peacock has just as long been known for pride. He is the gaudiest of all tame birds. When he lifts up his long tail feathers and spreads them out like a fan, with all their "eyes" showing, he is a royal sight to see. Then he also has a crest of feathers on his head, a neck and breast of beautiful purple, and a back of green with golden-brownish lacing. He carries himself like a king.

He came from Southeastern Asia, where he was a relative of the wild jungle fowls and pheasants. He has not always escaped our tables, as he usually does now. In the Middle Ages he was served at royal feasts in some countries, though in others he was never eaten at all because he was thought to be unclean. As a matter of fact he would be very good eating if we cared to spoil his beauty.

The Graceful Swan

The snow-white swan is one of the loveliest of all birds, tame or wild. He is famous for his long and graceful neck, which he wreathes about as he floats or paddles on the water. In former times the feathers from his breast were in great demand for stuffing pillows and cushions, and his skin, with the feathers on it, was often worn as a "chest protector." Many a fine swan was killed for his feathers in those days

Now the big birds are kept only for their beauty, mainly in mild climates where the water seldom or never freezes. In England half the swans on the Thames belong to the King and the other half to the Vintners' Company. For some reason they have been owned in this way ever since the Middle Ages. Of course the King and the Vintners would never quarrel over a swan. All they want him to do is to float on the river, and they do not care a penny who owns him. But England loves to keep an old custom. So once a year some gentlemen start up the Thames from London in two boats, clad in the brilliant uniforms of ancient days, for the sole purpose of marking all the newborn swans on the river—half for the King and half for the Vintners.

In the years just before and during World War II, when meat was scarce in the world, the poultry and egg business grew by leaps and bounds. No longer is it merely a farmer's side line, carried on by the farmer's wife in her spare moments. It is now a vast industry in which tens of thousands of people are employed. Roasters, broilers, and eggs are turned out much as they would be in a factory, and are marketed by the large-scale methods used in any great industry.

Shops that sell nothing but poultry have sprung up in our large cities. Supplies come to them fresh every day, and since the birds are raised scientifically under conditions that are carefully controlled, the stock is uniform and of high quality. There is no chance of your getting a tough old hen, as there used to be when the farmer's wife went out and wrung the neck of a bird because it was too old to lay. Moreover, poultry parts are now sold, and you can buy the parts you like best—breasts, drumsticks, or wings.

Packing Plants for Poultry

More and more of the farmer's chickens are bought by big poultry processing houses that sell to dealers in every part of the country. The farmer takes his live birds to the nearest of many small collecting stations that are scattered over the agricultural districts and there he sells his produce for cash. Trucks pick up the live poultry—sometimes at the farms themselves—and take it to the processing plant, where the birds are fed and coddled for several days. Then they are hung by the legs on a moving belt, are killed painlessly with an electric knife, are dipped in scalding water, and then proceed to an automatic "rougher" on which the feathers are rooted out by a set of big rollers equipped with revolving fingerlike projections. Next the birds are dried and dipped in hot wax. When the wax hardens and is pulled off, it brings all the tiny feathers and hairs with it.

Now the birds are ready to be cooled, graded, and wrapped for shipment. Often the internal organs are removed, and if the birds are to be quick-frozen, the legs and head are removed also.

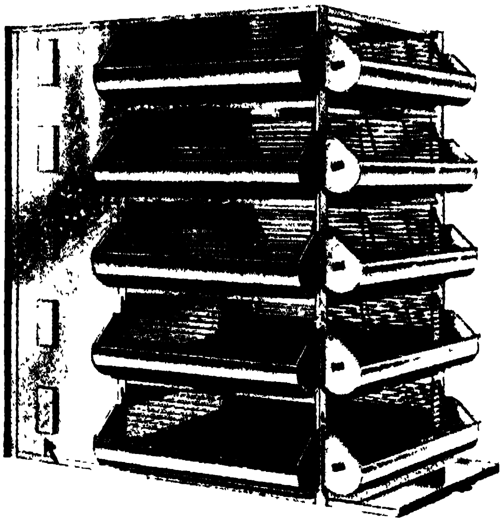
If the internal organs are to be taken out, the birds are laid in pans on a moving belt or are hung from moving chains. They are carried along past a series of workers each one of whom does a single small operation in the process. A government official always examines the organs that are removed to be sure that the bird was not diseased. The internal fat goes to make soup, and the oil sacs in the tail are used in medicine. Heads and feet are sold to fish hatcheries to feed the fish, and the feathers used to make pillows. If the birds are to be canned they are cooked in a loose mesh bag and the meat is removed from the bones.

If the poultry is to be quick-frozen it is packed in boxes and put under pressure at a temperature of 35° below zero, or it is put in a wind tunnel where the temperature is 40° or more below zero. The sudden freezing at these low temperatures keeps the cell walls in the flesh from being ruptured.

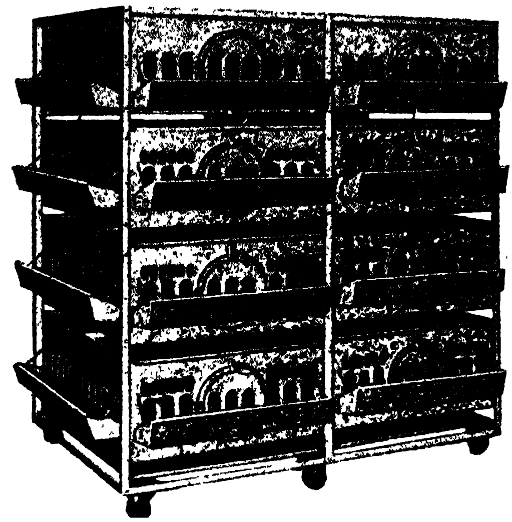
Lately a way has been found to make the feathers into a light warm soft fabric, which takes the dye nicely, will wash well, and wears a long time. Of course it will be some time before much of it is manufactured.

Often the processing plant interests itself in the raising of the birds, especially if they are turkeys—which are hard to nurse along. It will guarantee a minimum price to the grower, will advance him feed, and even supply the baby turkeys.

Besides processing poultry for the table the big plants also dehydrate eggs—that is, powder them, so that they will keep longer and take up less space in shipping. At a temperature of 70° dried eggs will keep for six months, and at 50° they will keep a year. The dehydrating takes place in a large machine three stories high and able to turn out 1500 pounds of egg powder an hour. Three dozen eggs are necessary to make a pound of the powder. Before entering the machine the eggs are broken by hand, and a small suction pump draws out that part of the white which clings to the shell. The liquid eggs then slide down over large refrigerated coils and are blown into the machine through a fan in the top. The blast turns the liquid



If you are planning to operate a chicken battery you will need to start your chicks in a brooder. The one shown above has five "decks"—or levels each one accommodating 125 chicks. The solid section at the left contains five electric-heating compartments, one for each deck, with thermostat control. A cloth curtain hangs between the heater and the front part of the brooder, where the chicks are kept, to protect them from drafts. Fresh air enters the heater through the slots marked by an arrow.



Chicks go into the battery brooder when they are a day old. A month later they are transferred to the growing and finishing battery, shown just above. Its top deck, with four compartments, holds chicks from 4 to 6 weeks old. The lower decks, also with four compartments each, handle birds from 4 weeks to broiler size when they are from 6 to 12 weeks old. The birds are kept in semi-darkness to prevent nervousness and cannibalism. This battery will hold 200 2-pound broilers.

eggs into a spray. Air heated to 400° is then blown in, and by the time the spray sinks to the bottom of the machine it has been turned into a fine powder. It now falls out of the bottom of the machine, ready for packing.

The Second World War brought an enormous demand for egg powder, and sixty percent of our eggs were at one time being dehydrated and sent to our armed forces and to our allies. In peacetime we use much less egg powder, for it is not so appetizing as fresh eggs. But it can be used in cooking. Sometimes the yolks and whites are separated at the processing plant for the use of bakers. Yolks alone are bought by manufacturers of noodles, and with salt added they go to manufacturers of mayonnaise. When eggs are to be frozen they are opened as for dehydrating and then subjected to low temperatures.

As the marketing of chickens has come to be more and more of a big business the raising of them has taken on factory proportions. A good many chickens are now grown in "batteries"—small cages set on shelves one above another. The chickens never see the sun, but are kept indoors and fed vitamins and cod-liver oil in their mash. Sometimes ultraviolet lamps are also used to give them the necessary vitamins. Under these conditions the chickens are protected from disease and take up much less space than when they are raised in the usual way.

A battery covering an area of fourteen by twenty feet—a battery of that size is called a "unit"—will be divided into four sections. One section holds 100 new chicks. The next section holds 100 "growers"—that is, chickens from four to twelve weeks old. The third section holds 72 "developers"—chickens from twelve to twenty weeks old. And the fourth section holds 48 layers—or chickens about two years old. Since half the young chickens are males they are sold off early to be eaten as broilers. Some batteries raise nothing but broilers and never produce an egg. Others keep the pullets—or young females—and produce eggs as well as broilers. A single "factory" of this sort will often contain thousands of birds. They don't have much of a life, but on the other hand they're safe from skunks and hawks.

WHERE OUR FISH COMES FROM

Reading Unit No. 7

HOW WE CATCH THE BIG FISH

Note: For basic information not found on this page, consult the general Index, Vol. 15.

For statistical and current facts, consult the Richards Year Book Index.

Interesting Facts Explained

How man became a fisherman. 9–361-62
The use of fishhooks and seines, 9–362-64
How salmon are caught, 9–364
Famous fishing grounds, 9–364-66
The life of a fisherman, 9–364-65
How great navies arose, 9–365-66
How we get fresh-water fishes, 9–366
How we use the products from the sea, 9–370

Things to Think About

How can a fishing seine net thousands of fishes?
What have fishing and great navies to do with each other?
Which food fishes are most plentiful in the sea?
What is done when a species of food fish becomes scarce?
How does man use fishes?
Do the important fishing nations show enterprise in other ways?

Related Material

Why is it easy to catch salmon? 3–246
How does the government help to increase the salmon population? 3–248
How does the halibut get both its eyes on the same side? 3–203
Why can meat and fish be preserved by drying, chilling, and salting? 9–326

Leisure-time Activities

PROJECT NO. 1: Make a survey of the kinds of fish and shellfish you can find in a large fish market, 9–370.
PROJECT NO. 2: Read Kipling's "Captains Courageous" or Melville's "Moby Dick" for an understanding of a fisherman's adventurous and lonely life, 9–365.

Summary Statement

Fishing, whether done with fishhooks or with giant nets, is a very large industry the world over. Many navies were first developed to protect the fishing grounds. The chief examples of salt-water food fish are the codfish, mackerel, halibut, and herring. Fresh-water food fish include salmon, perch, whitefish, lake trout, and shad.

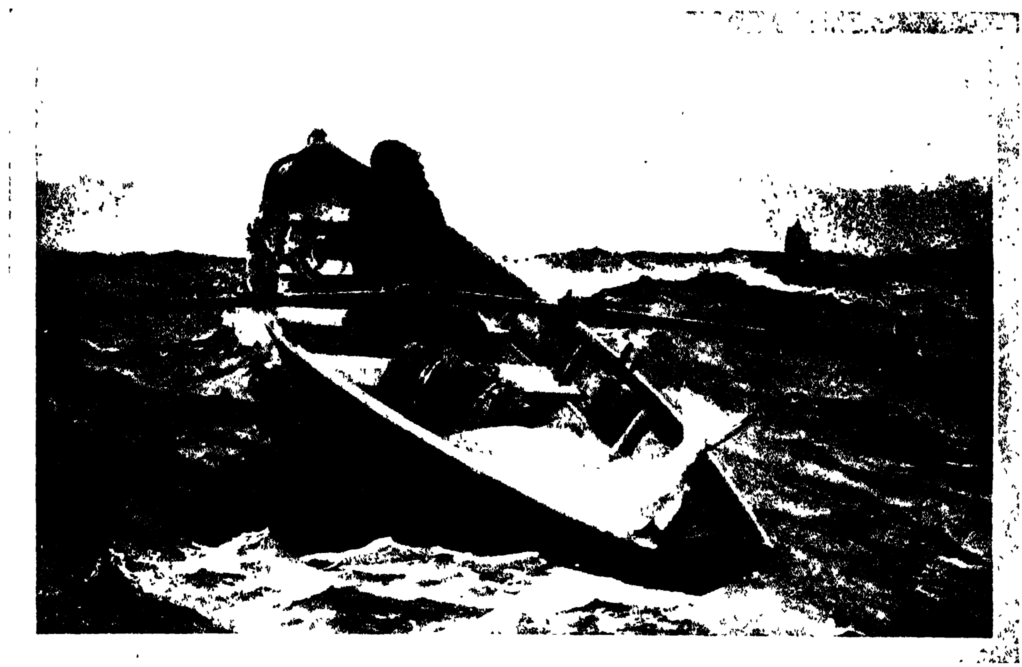


Photo by Museum of Fine Arts, Boston

Many are the wiles, even now, of "dat ol' debbil sea." No one knows that better than our sturdy fisherman, who is eying with distrust the first warning of fog. Be the fishing ever so tempting, he had better turn his dory about and row for the safety of the mother ship, whose sails are spread against the horizon.

HOW WE CATCH *the* BIG FISH

And How We Also Get Millions of Smaller Ones Out of the Sea for the Supply of the World

IT MAY well be that the first animal a man ever ate was a fish, and that he found out something about getting his food out of the water even before he learned much about catching it on the land. At any rate, catching fish by some means is a very old thing with the human race.

At the very first a man must have had nothing but his bare hands to catch the fish with, and there are some kinds of fish that can be caught, from time to time, with the hand alone--if the hand is expert enough. But that first man must have often gone without his dinner. Later he must have made some sort of sharp stick to spear his fish with, and still later he would put a tip of sharp stone or finally of metal on the stick. There is still such a thing as spearing fish, either for sport or for daily food. As long as the man used a spear, he was simply depending on his strength and skill to get him his food.

Then he began to use his wits instead of his mere strength. He made some sort of hook and line. Probably the first line was a strip of skin or a piece of vine, and the first pole was just some little sapling such as many of us cut when we go fishing to-day. They would do well enough—better than his hook, which was at first probably a piece of thorn or bone. It may have been about as good as the bent pins with which we sometimes try to catch minnows now. The trouble with a bent pin is not that it will not catch the fish, but that it will almost never hold him. He wriggles off, and vanishes. So a long time ago our man found a way to make a "barb" on his hook—a little prong right at the point that would hold the fish all the tighter as he struggled and

floundered to get free. When the man got to this point he was a pretty good fisherman. For by this time, of course, he had watched the fish enough to know a great deal about them—where they were likely to be in the water, when

they would be likely to want to eat, what sort of bait would tempt them most, and many of the other things that the fisherman is so proud of knowing.

Photo by American Museum of Natural Histo

If it were not for their fishing, the Eskimos of the frozen north could never live. They must fish as they can, between giant ice floes and in deep-frozen waters, using the simple methods which their ancestors have known time out of mind. Above is an Eskimo woman fishing with a line through a hole in the ice. In the center is an Eskimo man harpooning a seal in a stretch of open water; below is another spearing a seal through the ice.

Since the first man made a good metal fishhook there has been no great change in the hooks we have used. They are just about the same as they always were, and perhaps they will never be very different from what they are now. It is hard to see how they could be much improved. But there has been a vast improvement in our ways of fishing, for all that, and we can now catch thousands of times as many fish as the first man with a hook.

For one thing, instead of a single hook, we can put two or more on one line. We can put out a thousand, or several thousand; and instead of sitting on the bank to watch them we can go away and come back to pull up all the fish at once that have been caught on our hooks. Of course that is no way to fish for trout or bass, when you are just out for sport; and if you did any such thing you would have to pay a fine and would probably be driven out of the county. But that is one of the ways in which the professional fishermen—the men who sail out into the deep sea to get the world its supply of fish—still use to catch us all we need for the market and the table. On the high seas it is not bad sport. There are plenty of fish, and the world wants them caught.

How Fish Are Caught for Market

Indeed, there are ways to catch more of them than by using a few thousand hooks on one line. For long ago the fishermen invented seines (sān) and nets to catch fish in greater numbers than the hooks would ever hold; and from that day down to our time the nets have gone on getting larger and better. Most of the fish we eat nowadays never felt the touch of a hook. They were taken out of the sea in nets.

Of these nets there are now a great many kinds. The simplest of them, and the least used, are stationary—that is, they are set out and fixed in one place to catch the fish. The ones that bring in most of our fish are

Photo by Dept. of Marine & Fisheries, Canada

Here is a trawler laying one of the enormous nets which catch most of our fish. When a net like this is drawn up and hauled on board it may contain as much as ten or fifteen tons of fish. On some codfish trawlers the fish are not only cleaned on board but cod-liver oil is extracted without so much as sending the fish to land.

movable, being pulled through the water by a boat.

The stationary net probably had a fairly simple origin. It must first have been some sort of trap for the fish. A network of strips or cords would be arranged through which the fish could easily pass in with the tide as it came in along a coast but the network would be so constructed that the fish would find it much harder to swim back through the meshes when the tide went out. We all know how this works in a wire rat trap, and the general principle would be similar. There are still a few fish traps of this sort in the world. And the stationary net is really like a big fish trap set at one place in a river or in the sea. It just waits for the fish to swim into it and get caught. They are caught in various ways. In the gill net they stick their heads through the meshes and then are caught by the gills when they try to pull themselves out.

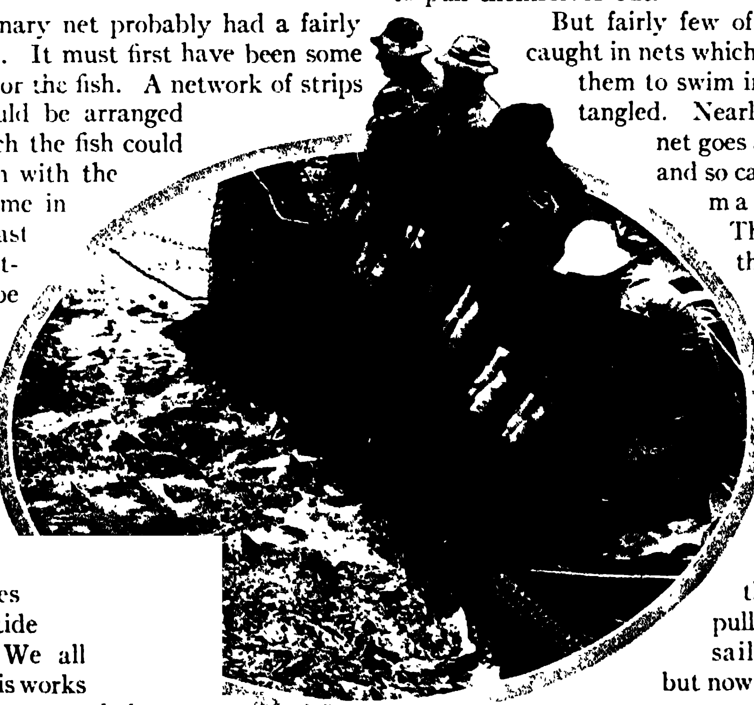


Photo by U. S. Bureau of Fisheri

Getting the haul on board is skillful and dangerous work—with the thousands of lusty fishes thrashing about in a mad desire to escape.

But fairly few of our fish are caught in nets which just wait for them to swim in and get entangled. Nearly always the net goes after the fish, and so catches a great many more That is to say the big net is pulled by a boat through the water where the fish are known to be. Not so long ago the boats that did the pulling were all sailing vessels, but now most of them are steamers. The steamers can handle better nets and cover longer distances; they can therefore go a good deal further afield in the search for the best fishing grounds, and in general secure more fish and get them to the market more easily. These boats are known as "trawlers," and we used to hear a great deal about them during the World Wars, when

so many of them were at work sweeping up the deadly mines of explosives with which the Germans strewed the North Sea and the Channel in the hope that British men-of-war and merchant ships would run into them.

Seines and Nets

The trawlers drag many kinds of nets through the sea, and the pictures will show you clearly how they do it. These nets are very large and most ingeniously constructed. The two main kinds are known as the "beam trawl" and the "otter trawl," but there are several special kinds of nets for special purposes. One of the most interesting is the "purse seine." This is a great net which is put out in a circle around the place where a "school" of mackerel or other fish are known to be in the water. When it has been run all around them, it is slowly drawn together, collecting the fish it has surrounded; and at the same time a cord like a purse string gathers it together at the bottom so that the fish cannot swim out under the sides of the net, but are caught in a large saucer of network. Then they can be simply lifted into the boat which has let out the net.

Photo by Canada Tourist Bureau

"No, I didn't bring any of them home—what would be the use? I don't like fish anyhow. But you should have seen the whopper I let get away!" Now are those other boys going to believe all this, or is it just another fish story?

Aside from these there are a great many kinds of nets, great and small, in the oceans and the rivers of the world. There is even a "fish wheel" in use, especially to catch the salmon in the Columbia River in the state of Washington. The wheel is fitted with a set of buckets, and as it turns round and round in the river, many of the salmon that are racing up the river on their annual pilgrimage to spawn will swim right into the buckets. Then it is all over with them. The buckets land them in a trough that carries them off into captivity—and in due time to our tables.

The fish we eat do not come from very far down in the sea. Some of the species swim right at the top of the water, and are caught in nets drawn near the surface. Others stay at the bottom near the shore, and the nets have to be let down and dragged along the ground for them. But hardly any food fish live in water of any depth. It is not easy to fish at a very great depth, and there are probably very few fish that live far down. So our fishing is done in water not more than a quarter of a mile deep at most, and by no means all over the ocean. It is mostly done on what we call the "continental shelf" of the various oceans—that strip of shallow water which we find around the continents before we get out into the deeps of the mighty ocean. There have been many famous fishing grounds—in the Mediterranean from the earliest times to now, in the North Sea and all around the British Isles, in the waters around Norway and Iceland, in those surrounding Japan, along both coasts of the United States and of Canada, and especially in the shoals bordering Newfoundland which we call the "Banks." No wonder that the nations living near all these waters are famous for their fisheries, and that the Banks of Newfoundland are one of the most famous fishing grounds of the world.

Some morning when you are on a big liner going to Europe, having gone to sleep the night before feeling that you were very much alone on the wide, wide sea, you will wake up to find your boat steaming through a whole colony of fishermen far out of sight of land. There will be a good-sized boat, probably a steamer but quite possibly a sailing vessel, and if the weather is not very rough there may be a whole family of stout little rowboats, or "dories," in the water around her. They will be scattered everywhere, bobbing up and down on the waves. The men in them will be pretty busy—by no means sitting and waiting for a bite—but they will have the time to keep waving at you as long as you are in sight. It is a good while since they saw anybody from

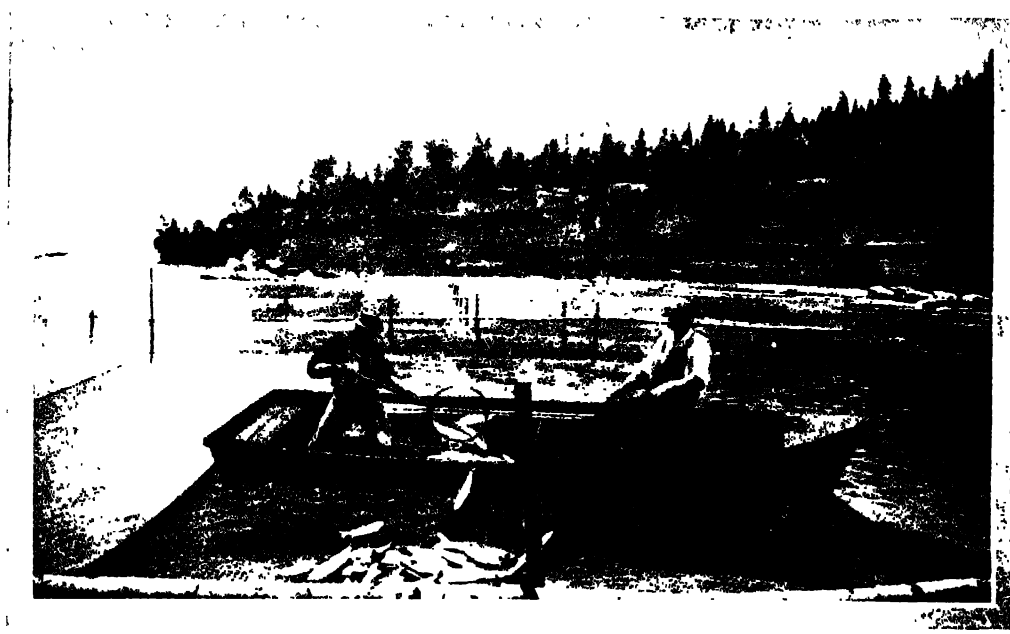


Photo Copyright by Milwaukee Public Museum

Here is one method of lake fishing in northern Wisconsin. Both Canadians and Americans fish in the Great Lakes, although the Americans do by far the most, taking out sometimes as much as forty or forty-five thousand tons a year Whitefish, herring, blue pike, and sturgeon are all abundant in these waters, as well as the trout, dear to the sportsman's heart. The fisheries here, as in every part of the country, are regulated by state laws; but there is a Bureau of Fisheries in the Department of Commerce which collects information from all the states, and finds out a great deal about fish and the best methods of catching them.

the land! They may have come out from Boston or from Gloucester or from Newfoundland, or they may even have come from the far-away coast of France. They are lonely.

These men lead one of the few kinds of lives that are still really adventuresome and perilous in our modern civilized world. For them the sea has nearly all the mystery and danger that it had in the days of Columbus. Even their big boat tosses on the waves like a shell, though she is fairly safe. But in their dories they may be upset at any time by a sudden squall, or even worse, they may be lost at any minute in a blanket of fog that will come down and blot out the sight of the parent vessel. It still takes a brave man to go fishing off the Banks or whaling in the Arctic, and many a courageous one has gone out never to see the land again.

The Fisherman in Literature

So there is a vast literature of the life of the fisherman, for his daring has not gone unrecorded in song and story. Many are the novels of the sea, many the romance of the fisher folk. Kipling's "Captains Courageous" and Herman Melville's "Moby Dick" are only two of the best-known books of this kind in our language, and Pierre Loti's (pyâr lō'tē') "Iceland Fishermen" is another classic of their life in French.

The Men Who Make Our Navies

These fishermen have made history, too. All the nations with long coast lines and abundant fishing have developed a great industry in fisheries, and along with it great navies to protect their waters; and what better sailors could they desire to man their navies than the fishermen who know the sea so well, and the sons of those fishermen, bred to the tossing waves almost from their cradles? So it is no accident that England has always had a great navy or that Norway has always abounded in hardy sailors, that the Japanese make fine seamen and that our own New Englanders, from such places as Boston and Gloucester, New Bedford and Nantucket, have been long famous for their prowess at sea.

WHERE OUR FISH COMES FROM

Down through the ages the British have been the greatest fishers of the world, though we and the Japanese have now gone ahead of them. The Dutch have also excelled, and at one time had a good deal larger industry than they have now; and aside from the peoples already mentioned, the French, Germans, Russians, and Canadians have extensive fisheries. But there is no nation and hardly any tribe that does not do a certain amount of fishing, and every nation with a good fishing ground near its coast has developed a considerable industry. The great fishing grounds of the world are around the British Isles, around the Scandinavian Peninsula, and in general to the north of Europe and Asia; along both coasts of North America and in the cold waters to the north of it; on the southeast coast of South America; all around the coasts of Japan and China and the Malay country, and on the fringes of Australia and New Zealand.

Photos by American Museum of Nat l History, & Canadian Marine & Fisheries Dept.

Here we have the long and the short of it! Above are girls packing the tiny herring into little tin cans to make "sardines"; and to the right is a Japanese spearfish caught off the California coast—a giant, as you see, twice the height of a man. The spearfish looks as dangerous as the poor little sardine is mild, but with fishes, as with men, it "takes all kinds to make a world."

Where Our Fresh-water Fish Come From

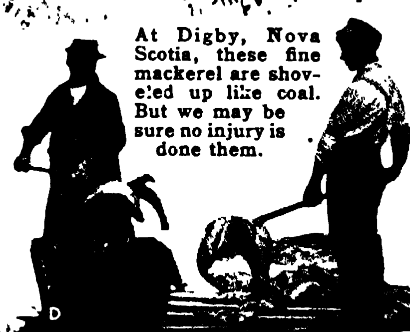
Though our own fisheries are mainly in the Atlantic and the Pacific, we have a considerable catch in some of our big rivers, like the Mississippi and the Missouri, and especially among the salmon of the Columbia. We and the Canadians also share the fishing in the Great Lakes, which yield a good supply of fresh-water fish, such as the lake trout and the whitefish.

We catch a great many kinds of fish, and their different habits make us fish for them in very different ways. The most plentiful fish from the sea are the herring, cod, haddock, mackerel, and halibut, though there are many others, such as the bluefish and the delicious little smelts. The herring are caught and eaten more in Europe than in America, though here also they are a favorite fish. They are taken in vast numbers when they swim into the shallower waters in order to spawn. The sardine is really a small herring called a pilchard—and is named for the island of Sardinia only when it has been imprisoned in a can. The mackerel travel in great "schools," thousands of them going along together and making the ripples on the water that tell the fishermen where to cast their nets. The cod was so important for the New England fishermen—and still is—that the figure of a codfish adorns the State House in Boston, just as a woolsack is the seat of the chancellor of the House of Lords in England. All these fish are well known to us, as are also the haddock and the halibut.

They vary greatly in size. The herring are small, seldom much more than a foot in length. The haddock averages two or three times larger, and the cod is a good deal larger still. He may easily weigh twenty-five pounds, and though we often see him smaller, he has been known to grow much bigger—as large as two hundred or more. The halibut is one of the flatfish, with both his eyes on one side of his head, as we have told in our story of life in the deep sea. This comes from the fact that he has the habit of lying on his side at the bottom of the ocean. He runs to about fifty pounds in weight. The beautiful mackerel, with his striped skin and fine meat, weighs about two pounds on the average; but he has a

A. It is not a haystack that this Nova Scotian is inspecting. It is a great pile of dried mackerel. B. The natives of Alaska hang the salmon catch out to dry in the sun as if it were the week's washing. Then they store it away till the winter.

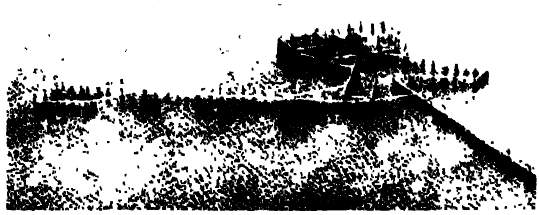
C. This rainbow trout, caught in Alaska, weighs seven pounds—and here is the photograph to prove it! E. Below is another scene from Nova Scotia: workmen salting and bareling mackerel at the Digby fisheries.



At Digby, Nova Scotia, these fine mackerel are shoveled up like coal. But we may be sure no injury is done them.

relative in the tuna fish, who is a giant weighing half a ton or more.

There is one fine fish of which most of us have never heard, because he has almost vanished from the sea. He is the tilefish. About fifty years ago we used to prize him on our tables. Then one day in 1882 a sea captain came into port and said that he had seen vast numbers of dead tilefish floating on the surface of the sea a little way out. The government sent out men to see what was the trouble, and found out that the strong winds had driven nearly all the tilefish into depths where they could not live. Practically the whole species was extinct, just as all the chestnut trees in the northeast of our land have died in our own day. So it was at once forbidden to catch any tilefish, in the hope that the few survivors might have a chance to raise up a new race. It seems probable that they have now done so, and that we are going to have tile on our tables again.



In the Pacific Ocean, for example in Alaska, salmon are frequently caught in a trap like that at the left. The fish are led into the trap by netting hung on piles.

Much more salmon is eaten canned than fresh, and salmon canning is one of the most important industries of Alaska. A huge steaming oven or retort, such as the one at the right, cooks thousands of cans at a time.

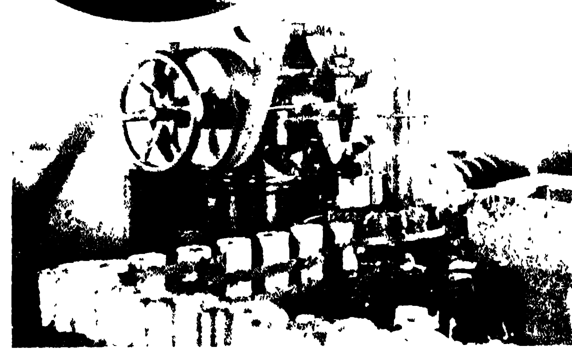


Photo by U. S. Bureau of Fisheries

Before the salmon goes into the retort to be steamed it has been cleaned by an amazing machine called the "iron chink," so named because it can do the work that used to keep many Chinese laborers busy. Another machine cuts up the meat and still another packs it into cans. Then the machine above puts on the tops and another machine takes out the air and seals the cans up. The sealed cans then ride to the retorts on hand trucks—the first operation, in most canneries, that is performed by hand.

The main fresh-water fishes that give us food are the salmon, perch, whitefish, lake trout, and shad. The shad, like the salmon, swim up the rivers in the spring to spawn, and are caught in nets in great numbers, especially in the Hudson and the Potomac. They have about the tastiest flesh of any fish in the world, though they are very full of troublesome bones; and there is no better eating than their roe. Of course the roe is the eggs of the fish, and we are killing thousands of little shad every time we eat a shad roe; that is one reason why we may wonder how long the shad are going to be plentiful. The lake trout and whitefish, which may grow to a pretty large size, come out of the Great Lakes and from smaller bodies of water, as do the perch.

In all this we have said nothing of the fish that are dearest to the heart of the sporting fisherman. We have been talking, not of sport, but of the world's food supply. But the fish that the sportsman loves, and incidentally eats when he can catch them, are the trout and the bass, and only a little less, the pike or pickerel. The trout is by far the most delicate eating of the three; but all of these fishes will tax the skill of the fisherman—to get them to nibble in the first place, and to land them with his slender rod and line. They give him the battle royal that he loves; and the big muskellunge in the northern lakes and streams, like the still larger tarpon of the southern waters, will afford him quite another fight still. It

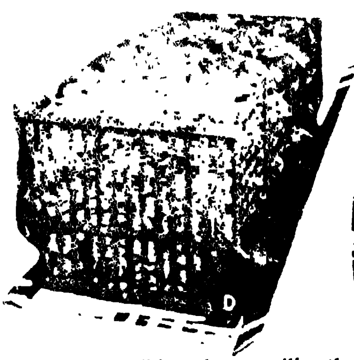
WHERE OUR FISH COMES FROM

A. Once all our oysters grew "wild" - that is, in natural beds like the ones these men are gathering.

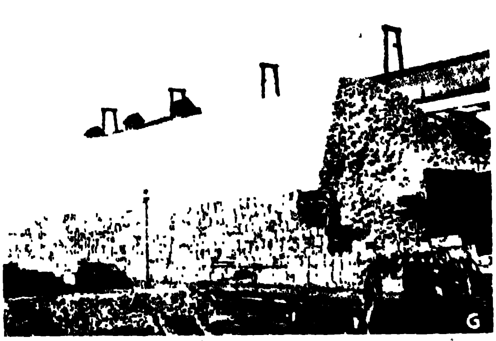
B. Lobsters live in shallow water, and are usually caught, as here, in wickerwork pots or creels. The creels are really traps, with funnel-shaped openings which let the lobster in easily but do not let him out.

C. This man is raking clams from the bottom of the water. A sight like this is common off the coast of New Brunswick or nearly anywhere from Cape Cod to Florida. Our fisherman is probably taking in hard-shelled clams. Those we dig up along the shore and eat at clam bakes are more likely to be the soft-shelled kind.

D. Here is a truck load of crabs that have just come out of the steaming oven.



E. Even if we did not keep spoiling the water by letting sewage drain into it, Mother Nature would have a hard time raising as many oysters as we eat. So now we raise them ourselves, as in this bed in New South Wales.



F. Every year millions of dollars worth of oysters are canned in the United States alone. Here are women at Norfolk, Virginia, taking oysters out of the shells. G. How many oysters helped make this pile of shells? H. Here are the oysters themselves in the process of being canned.

is no easy thing to land a tarpon weighing twice as much as a good-sized man. Those of us who have to be content with less heroic fishing can still get fun in catching the homely catfish, to be found nearly everywhere and to be handled carefully on account of his sharp fin, which can give one a painful stab. Or we can hook the beautiful little sunfish, which is as good to eat as he is to look at.

We have said nothing about all the shellfish and other creatures we take from the waters. Oysters alone are an important industry in the United States, the most valuable product of her fisheries. They come largely from the coasts of Maryland, Virginia, and New York. Besides these there are lobsters, crabs, clams, mussels, shrimps, turtles, and even frogs. And we can add the whales and seals and walruses. Not all of these creatures are fish, but the capture of all of them comes under the title of fisheries, as may even the search for sponges and pearls.

The Wealth of the Sea

We get many a million dollars worth of food out of the waters every year, and it is the only great supply of food that we do not have to raise ourselves. Our meat from the land is nearly all from tame beasts and our fruits and vegetables are nearly all cultivated. In the sea, the food simply grows up wild. We use the yield for many other things besides eating. The Eskimo uses seal and walrus oil to light his lamps and heat his ice hut, and we use fish oil in many medicines, such as cod-liver oil, and for various other purposes, such as making soap and tanning leather. The flesh of fish is a valuable fertilizer. One of the things American settlers learned from the Indians was to put a fish in each hill of corn they planted. Certain fish skins, especially the shark's, are made into fancy leather.

The menhaden (mĕn-hā'd'n), taken along the Atlantic coast, is America's most useful and valuable fish in industry. It makes up a fifth of the country's catch, but it is rarely eaten. It is made into fertilizer and into a kind of meal that is a very good food for livestock and poultry. In addition its oil is used in many industrial processes.

Very few kinds of fish meat will keep at all well. It is the most perishable of our flesh foods. For that reason the people living far from a coast seldom or never used to get fresh food from the sea. Any salt-water fish they ate had been put up in salt or brine—or even in lye. But with the coming of refrigerator cars a great many more fresh fish have found their way throughout the country. And with the vast growth of the canning and quick-freezing industries we now put up seafood to last a long time

Our picture shows the crowds and apparent confusion in a great fish market in the early morning hours, when the night's catch is bought and carried away by dealers. Here in the Fulton Street Fish Market in New York City fish and shellfish come in from Long Island Sound and Atlantic waters. This is the second largest fish market in the world. Only Billingsgate Market in London excels it. Both are famed for the quantity and variety of their fish. And Billingsgate has given its name to the picturesquely abusive language heard there.

Photo courtesy New York State Conservation Department

Reading Unit No. 8

THE NEXT BEST THING TO BUTTER

Note: For basic information not found on this page, consult the general Index, Vol. 15.

For statistical and current facts, consult the Richards Year Book Index.

Interesting Facts Explained

People who cannot obtain butter, 9-372

Millions of dollars' worth of artificial butter, 9-372

Two kinds of butter substitutes, 9-373

What butter substitutes contain, 9-373

The invention of oleomargarine, 9-372

Why is oleomargarine yellow? 9-373

Oleomargarine during World War II, 9-373

Making butter and its substitutes, 9-373

Things to Think About

Why do many Europeans never use butter?

How many different materials are possible sources for oleomargarine?

Would it be better never to add coloring matter to margarine?

How is oleomargarine kept pure and wholesome?

Why do we use oleomargarine instead of jam or peanut butter?

Related Material

What substitutes for butter do campers use? 14-552

What is the annual butter production of the United States? 9-338, 341-42

What is butter fat? 9-334

How is milk tested for butter fat? 9-342

How is butter churned? 9-340-42

How is fat stored in the human body? 2-301-02

How do the body cells use fats? 2-362

Why do we need vitamins? 2-263-05

Practical Applications

How is an appetizing substitute for butter made? 9-372

How are many by-product fats changed into butter substitutes? 9-373

Leisure-time Activities

PROJECT NO. 1: Collect samples of edible fats, 9-373

PROJECT NO. 2: Compare the taste of margarine with the taste of butter, 9-372-73

Summary Statement

Oleomargarine is made from many edible fats, and tastes like butter. Vitamins are added to give the same food value.

This is how we make the neat blocks of oleomargarine that you may buy at the grocer's. Great masses of the imitation butter are fed into a machine which presses them through a mould into an endless rectangular block, which is then cut up into chunks of the desired length as fast as it comes out of the mould. The machine has to be kept absolutely sanitary, and the oleomargarine is never touched by hand. You will notice that the man in the foreground is wearing white gloves.

The NEXT BEST THING *to* BUTTER

How Man Has Stolen the Cow's Secret and Makes Millions of Pounds of Margarine a Year to Take the Place of Butter for Those Whose Pocketbooks Are Slender

IF YOU were a Frenchman, a German, or an Italian you would hardly know what it is to have butter on your bread. If your family was well-to-do, you might have a very little of it to go with your roll for breakfast, but you would seldom see it served at any other meal. And if you were poor, you could never have it at all, for in those countries butter is rather a luxury, and not many people put it on the table.

And yet how flat your bread would taste without its yellow dressing, and how dry the meal would seem! It was because of this that the French government once offered a prize to anyone who could invent a substitute for butter that should be cheap and nourishing. And it was a French chemist named Mège-Mouries (mĕzh-mōō′rē′) who about 1870 won the prize. Ever since then other scientists have been experimenting with his invention and improving upon it.

By the end of World War II a substitute for butter could be made to look and taste so much like butter that it was often almost impossible to tell them apart. To-day in the United States alone millions of dollars' worth of the substitutes are sold every year. And since they are so much cheaper than butter, you may imagine how much they add to the meals of thousands of poor people.

Now all the various substitutes for butter go by the name of oleomargarine (ō′lē-ō-mär′jȧ-rēn). But only certain of them contain oleo, an oil made from beef fat. So it would be better to call them all "margarine," a word that comes from the Latin term for "pearl." When you see the pearly luster of uncolored margarine, you can guess how it got its name.

There are two main kinds of margarine, though they look and taste very much alike. One is made largely of animal fats, and since it contains oleo it may properly be called oleomargarine. The other contains no animal fat at all, except for a certain amount of milk and butter; it is made from vegetable oils. Altogether the margarine factories in the United States turn out many millions of pounds of margarine in a year. It is made in a number of different ways, and from a good many different materials oleo oil, oleo stearine (stē′ȧ-rĭn), which is the hard part of beef tallow, or what is left when the oleo oil has been pressed out. "neutral," which is only another name for the purest lard, made from what is known as the "leaf," or the fat around the kidneys and other internal organs of the hog, and taking its name from the fact that it has no flavor, odor, or taste. oleo stock, also taken from beef tallow, milk butter, which is limited by law to not more than 10% of the finished product; coconut oil, which is made from coconuts, cottonseed oil, which is pressed from the seeds of the cotton plant, and is also used in a good many salad oils, peanut oil, which, as we know, is rich in food value; and salt. Vitamins too are added.

What the Cow Gives to "Oleo"

Milk is necessary in making every kind of margarine, for with its curd the fat must be combined in order to give a smooth, butterlike consistency to the finished margarine. The pasteurized milk is artificially soured by the addition of certain tiny organisms which, in growing, always turn the solids in the milk to curd. Then the fats, or oils, are added, and the whole mixture is thoroughly churned and chilled. Now it looks like freshly-made butter floating in its buttermilk. After the buttermilk is drained off, the margarine is "worked," or kneaded and rolled till it is just the right consistency; then salt is added and the product is packed by machinery in cartons, just as butter is.

Why "Oleo" Looks Like Butter

Sometimes coloring matter is added, to make the margarine look like butter, for pure margarine is white—and indeed pure butter is usually very pale in color. But there is a tax of ten cents a pound on colored margarine, so the coloring matter is often included in the package separately, and the housewife can add it herself. Of course there is really no need to add it at all. The only reason why we put it in is that we are used to seeing our butter look yellow—though it too is very often colored artificially. But because we are used to having it yellow we think we can never eat it any other way—and so we often pay ten cents a pound just for a color.

When Uncle Sam Is Chief Inspector

No food product is manufactured under closer inspection and more searching supervision than margarine. Every step is watched. The manufacturer is required to inform government inspectors in advance when he intends to buy certain materials for making margarine, and these are inspected both before and after they come into his hands.

So we may always be sure that margarine is pure and wholesome. That is one reason why its use has increased so greatly, in spite of the fact that there has always been very bitter opposition to its manufacture and sale. Another reason for its popularity is that it contains just as much nourishment as butter, and is just as digestible. When absolutely fresh it has the flavor of butter. During World War II, when the United States had to feed not only our own people and our own fighting men but also hungry people all over the world, we should have been in a bad way if we had not been able to fall back on margarine.

The STORY *of* BUILDING MATERIALS

Reading Unit
No. 1

WHAT WE NEED TO BUILD A HOUSE

Note: For basic information not found on this page, consult the general Index, Vol. 15.

For statistical and current facts, consult the Richards Year Book Index.

Interesting Facts Explained

The cave man's home, 9–375-76
Rock and brick in days of old, 9–376
Brick and tile making, 9–376-78
Constructing brick buildings, 9–379
Stone for buildings and for ornamentation, 9–379-80
Steel buildings, 9–380-82
Cement, concrete, and plaster, 9–382-84
Glass for our windows, 9–385

Things to Think About

Why did the ancient Egyptians make bricks instead of using stone?
What was wrong with ancient bricks?
How has steel changed the method of constructing buildings?
How are buildings fireproofed?
What are the qualities necessary for ideal building materials?

Related Material

What was the architecture of colonial houses? 11–502-8
Where do people live in tree houses? 11–396-97
Which people live in houses on stilts? 11–399
What kind of buildings did the Greeks construct? 5–170, 12–178
What was the Roman method of building construction? 11–434, 12–179
What kinds of houses were found when Pompeii was unearthed? 5–257-60
How are steel beams manufactured? 9–398-408

Practical Applications

Why are we using prefabricated houses? 9–386
How can man make stone to suit his need? 9–382-84

Leisure-time Activities

PROJECT NO. 1: Build a model of a primitive dwelling, 9–376-77.

PROJECT NO. 2: Build a cardboard house, 14–10.

Summary Statement

Man builds houses from very much the same materials that were used in the past, except that steel has been added. Steel has changed both the method of building and the kind of houses built.

The English countryside is dotted with charming little cottages like this one, so substantial, so picturesque, so well adapted to their surroundings that one could almost imagine them to be part of the soil. Not all of them have this quaint roof of thatch, but nearly all of them are built of stone. A thatched roof is made of a very thick, firm layer of straw, fastened down in the manner shown. Old thatch often gives a foothold to various little wild flowers, and then it is as pretty a roof as one could wish to see.

Photo by L. M. & S. Ry

WHAT WE NEED *to* BUILD *a* HOUSE

How We Have to Dig and Melt and Bake and Saw to Get the Things That Go into Our Houses

WHAT would you do if you were caught out in the woods some rainy night without a tent? If you had a hatchet, you could cut branches off the trees and try to make a roof over your head. And you can make a pretty good roof in this way, if you know how.

Long ago, before our ancestors had any tents or houses, they knew the trick pretty well. Of course they lived in a cave when they could find one, and they often dug their own cave when they did not have one ready-made. But in time they also learned to cut off branches from the trees and build rude huts with them. Yet they were a long time learning how to build and what to build with.

At first they just used poles and branches laced together and sometimes covered with mud that dried out in the sun. Slowly they found out how to make use of other materials. After thousands of years they had learned how to employ four main materials—wood, stone, brick, and straw. Much later still, in Roman times, they also had tile, cement, and plaster.

In the early days before the dawn of history, men had to use the wood just as it came from the tree, in logs and poles. We are still doing the same thing whenever we build a log cabin. But in the long ago there was no way of sawing out such planks as we have now, for the best tools to be had were nothing but pieces of sharpened stone. Many centuries later men were making saws of bronze or copper, and with these they could cut out planks, though it took hard work. Only within the past two thousand years have we had good saws of steel; and only in the past century or so have we operated them with anything but our own hands.

And stone took far harder work than wood. In a rocky country it was easy to pick up enough stones and pile them into some sort of wall, but to make a house the stones had to be fitted close together, and that meant chipping them till they were smooth, or "dressed." Yet without any steel or iron chisels the patient men of old would sometimes shape their stones as smoothly as if they had been cut by the best

machinery. In many parts of the world there are ruins of great stoneworks left from the hands of men long since forgotten.

The most useful of all the old materials for building was brick. Bricks were small and light, and easy to handle. They were made of clay mixed with sand and baked till they were hard. In Bible times the workers put chopped straw in the bricks to hold the clay together.

Bricks are found in many of the oldest buildings. Six thousand years ago the houses and walls of great Babylon were built of brick. Wherever stone was hard to find, brick would be used instead.

Savages would often use branches of trees, and straw and big leaves, in making their huts. Some of them do it to this very day. And they would often make small houses out of clay baked by the sun into what we call "adobe" (à-dō'bĕ). The Southwestern Indians—and white people too—still build houses out of it.

Like other savages, an Apache made his house of materials that lay close at hand and were easy to gather. Here is one of his houses under construction, from the first rude framework of slender boughs to the finished tepee. It is clear that such a home was more picturesque than comfortable.

Photos by American Museum of Natural History

How We Make Our Brick

If a man from the olden time could see one of our great buildings of to-day, or even one of our modest dwellings, he might find it hard to think that they were made out of the same materials that he used to have. But though we have many new materials, our main work is done in wood and brick and stone. And yet our brick, or even our wood and stone, is so different from the ancient kind as to seem almost like something new.

The bricks of olden days were long, thin, uneven slabs of clay, and often poorly baked. The bricks we have now are always well baked, and always of a standard size and quality, though there are many different grades and kinds.

The clay for bricks can be found almost anywhere. In America there are brick factories near every large city, as along the Hudson River above New York City. When the clay comes to the factory it is mixed with sand and water until it makes a stiff mud. The mixing is done in a machine with a queer name—the "pugmill." It is a little like a great churn, with blades that whirl round and round through the mud to do the mixing.

Then the mud is forced through a small tunnel just the size of a brick. So out at the other end comes a long stream of stiff mud which needs only to be cut off into the right lengths for bricks. And the cutting is done by little wires that come down and go through the stream of mud at the right moment. The whole affair goes so fast that a single machine can turn out 100,000 bricks in a day.

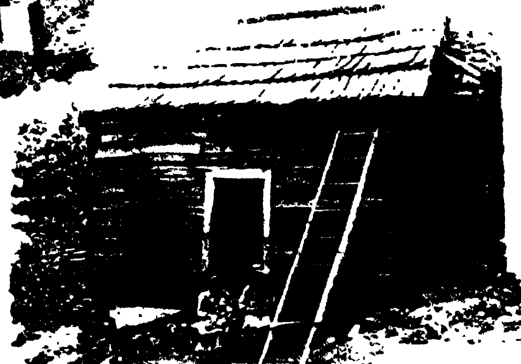
There is another kind of machine that

1—Laplander's deerskin house for summer weather.

2 -Native hut of reeds and straw, West Africa.

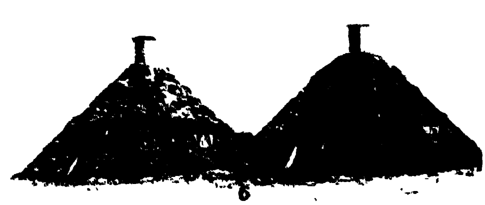
3--The Nigerians, West Africa, have learned to make mud-plastered houses.

4—Pioneer log cabin, with hand-made shingles and ladder leading to loft.



5—West African native hut, made of reeds, straw, vines, and other dried vegetation.

6—Laplander's winter dugout, made of mud over a wooden framework.



Photos by Centerville Clay Products Co. and Visual Education Service

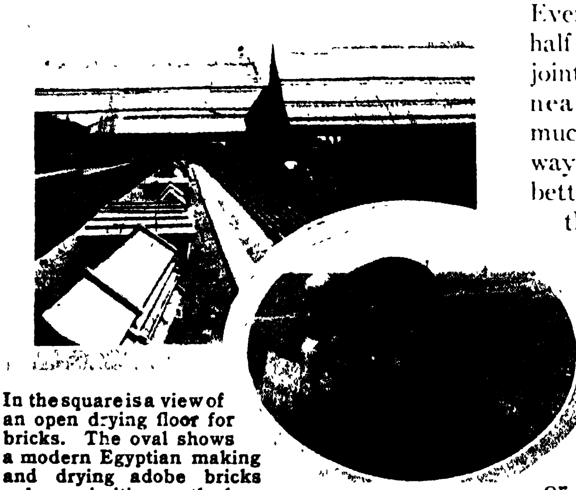
In the upper part of the picture is a modern brick-yard, showing the dome-topped kilns for baking the bricks. Set in along the bottom of the cut is a close view of four of the little old bricks made thousands of years ago in Ur, Abraham's birthplace. The marks stamped into their sides tell us their age.

presses the mud into moulds, a hundred or more at a time, and turns it out as brick.

But it is not very good brick yet. It would turn into mud again in a hard rain, and wash away. That was the trouble that the first men to use brick had with it. By and by they learned that it could be made to stand any storm if it were well burned first.

When the bricks are first cut they are carried by long belts to sheds where they are piled to dry. After a few days, or possibly a few weeks, they must be burned in a kiln to harden them. A kiln—we usually call it "kill"—is really just a great hot oven. In it the bricks are stacked with little spaces between them to let the heat get to every part of them, and there they stay to burn for a week or more. Common bricks are burned to a red heat; fire-bricks—the kind we use in furnaces to melt iron—are made white-hot.

When all this is over, the bricks are ready to start out on their career of usefulness.



In the square is a view of an open drying floor for bricks. The oval shows a modern Egyptian making and drying adobe bricks by a primitive method.

Photo by N. Y. Brick Handling Co.

Bricks are laid with mortar to make walls. Every brick should lie half way across the joint of the two beneath it—they are much stronger in this way, and they look better. We may make the whole wall out of brick, or we may put them only on the outside, to look well, while the real wall behind them is made of wood or steel. In many a modern building the steel frame stands all the strain of the walls, and the bricks are put on merely for appearance and protection from the weather. That is called a "curtain" wall.

Brick is not the only form of clay we use

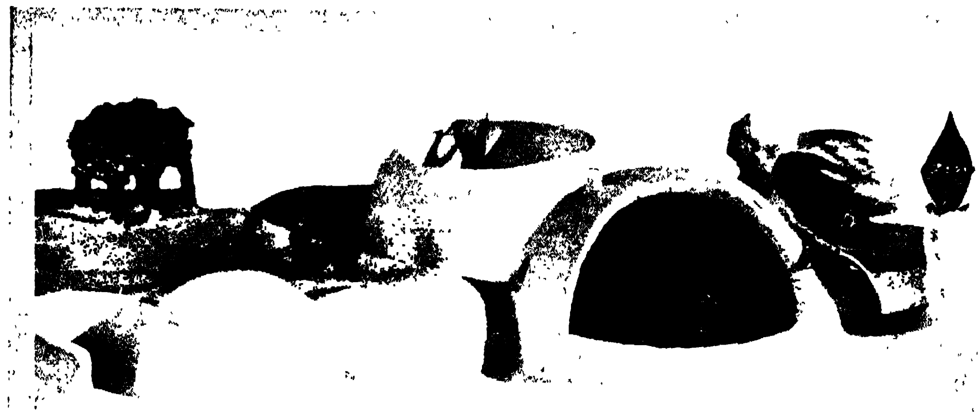


Photo by American Museum of Natural History

Here is a photograph of a model that shows how an Eskimo's igloo is built out of snow and blocks of ice. Sometimes those are the only building materials he has at hand, but they are very enduring in his climate.

in building. Since the early days of Greece, tile has also been employed for roofs and floors and decorations. Nowadays we sometimes make whole buildings out of tile, or "terra cotta," as we call it; the words are Italian and simply mean "cooked earth." And our tiles may be made in rough, hollow blocks to use inside the walls and under floors, or they may be carefully moulded and shaped into designs for the outside ornament of houses. For ornamental work the tiles are made to order; they are often colored and are always given a hard, glazed finish. The rougher tiles are made by machinery, more or less like bricks, thousands at a time.

The Tiles on Our Bathroom Wall

The tiles on a bathroom wall are commonly made of white clay and given a glazed surface. All clay tiles have to be burned, just as bricks are, for five or six days. If they are to be glazed in addition, they are then painted with a glazing mixture and baked again. The glazing mixture is made out of chemicals that form a shiny film over the tile as it is baked.

Of stone there are many kinds that we can use in building—marble, limestone, and granite, sandstone, and slate. All of these come out of quarries in the earth. Often the quarries follow the stone ledges for hundreds of feet into the ground.

It is still heavy work to quarry stone, though we now have electrical machinery to make it easier. We take out great blocks of granite or marble by drilling holes all around them and cutting them loose. Then we haul them out of the quarries with electric cranes. We have taken out blocks weighing over sixty tons, but commonly they weigh about fifteen. Fancy the labor it used to take to get out stone enough to build a pyramid!

Giving Stone Its Shape

When the rough stones have been lifted out of the quarry, they are carried off to a mill. There they are worked into any shape that may be wanted. If a long round column is desired, the block of stone is put into a great lathe and turned round and round. As it turns, the rough corners are gradually ground away until a smooth round shaft is left.

How We Saw a Stone

If thin slabs are wanted, the stone blocks must be sawed into strips. The saw we use for cutting stone has no teeth. It is a band of steel that works back and forth on the stone while sand and water are poured on it. The gritty sand rolls between the iron and the rock, and cuts a groove as cleanly as a knife.

Still more remarkable for cutting stone is the diamond saw. This is a disk of steel with diamonds set all around its cutting

edge. There is nothing that will cut like a diamond; and as this saw whirls around some six hundred times a minute, it shaves through the hardest marble as if the stone were mere wood.

Carving Stones with Air

Then there are machines for smoothing blocks of stone, for polishing them, and for cutting figures and designs in them. But any special design, such as you may see atop a column or over many church doors, has to be carved in the stone by hand. In the old days the sculptor did the carving with a chisel and a mallet. Now he has a patent chisel that operates with compressed air.

In America a great deal of granite comes from Connecticut, Massachusetts, and Minnesota; marble from Vermont, Tennessee, and Georgia; and limestone from Indiana, Kentucky, Illinois, and New York. Sandstone comes from most of these states too. In Italy there are famous quarries at Carrara (kär-rä'rä) that furnish beautiful marble. And of course there are other quarries in every country of the world.

Shingles of Stone

There is still another valuable stone for builders, though they never make a whole house of it. This is slate, the stone we use so much for roofing.

The best thing about slate is that it splits easily into thin strips. So it would not be very good in holding up a wall, but is excellent for making a light stone roof. For that purpose the slabs are cut to a small, convenient size, and have two holes drilled in them for the nails that hold them on. They are really just stone shingles, and are laid on overlapping, just as wooden shingles are.

There is no better roof than one of slate. It never rots or warps or wears away from rain or snow. There is nothing that lasts longer or looks better.

In the United States most of the slate comes from Pennsylvania. In Europe the best quarries are in Wales, but there are others in many countries. A good deal of stone is wasted in the quarrying, and it takes six tons of rock to yield enough slate to cover a small house.

Our Bungalows of Wood

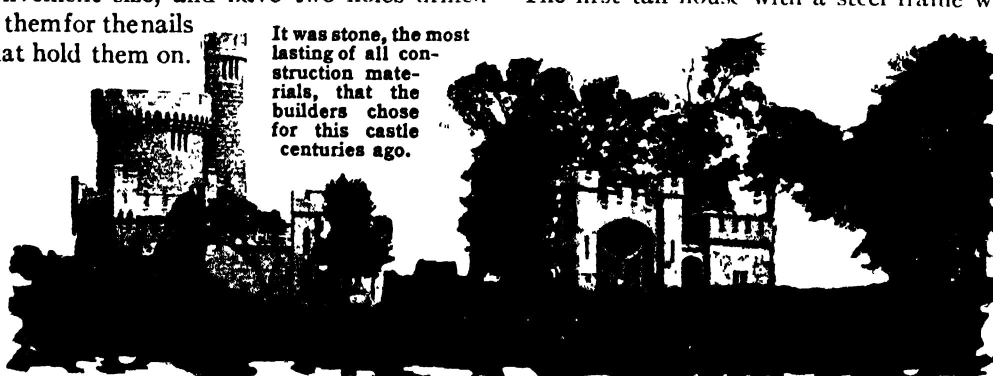
Brick and stone are the best things for building, because they cannot burn and because they last so long. But in America most of the small houses are still made of wood because it is so much cheaper. And very pretty houses can be built of wood.

In our story about lumber we have told how the trees in the great forests are cut down and floated off in the rivers to the mills where they are sawed into smooth beams and planks, or turned into special shapes for staircases and all kinds of woodwork. Even a wooden house can be built sound and strong enough to last for several centuries.

The Steel Bones of a Skyscraper

But in our great buildings very little wood is now used. It would never have the strength to hold them up. For the great weight of a skyscraper we need steel and concrete.

Steel is a very new thing for the builder. The first tall house with a steel frame went



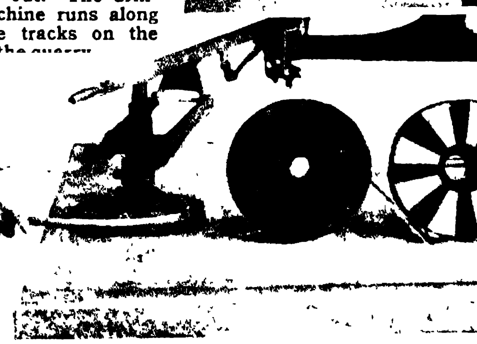
It was stone, the most lasting of all construction materials, that the builders chose for this castle centuries ago.

Photo by L. M. & S. Ry.

2—Steel bands, with the help of sand and water, saw the marble into slabs. Sometimes saws with diamond-set edges must be used.

3—A pneumatic chisel, driven by compressed air, does most of the marble cutter's work.

1—Marble is too valuable to be blasted out of the quarry. Electric drills cut it into blocks, which are then wedged out. The drilling machine runs along movable tracks on the floor of the quarry.



4—A slab of marble is smoothed on a rubbing bed consisting of a revolving metal plate over which sand and water are kept constantly flowing.

5—Marble is polished in a machine that holds the stone directly under a series of revolving metal disks which turn above it. The disks, shown here, are coated, the first with carborundum, the next with aloxite, the third with fine hone; and the surface of the marble is kept wet. A final polish is given with felt and a polishing powder.

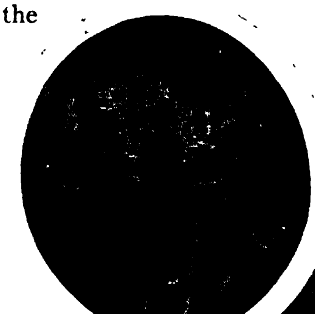
7—This gigantic marble column is on its way to hold up the roof of a cathedral.

Photo by Vermont Marble Co.

up in 1886; yet at the present time nearly every building over four stories high has a frame of steel. The frame holds up the building just as the frame of bones inside holds up a human body. So we now have buildings eighty or ninety stories high with glass windows all around the ground floor, making the whole thing look as if it rested upon glass. Of course it really rests on immense steel columns sunk deep into the ground and towering into the sky.

In such a building the great steel skeleton goes up first and carries all the load. All the other materials—the brick and stone, tile or concrete in the walls and floors—are merely hung upon the frame. Once the frame of steel is up, we can begin at the top and build the walls downward if we want to do so.

In the story of steel and iron we have shown how the strong steel beams and girders are made and shaped. When we draw up the plans for a big building, we have to make a picture, or "print," of every piece of steel that is going into it. Then we send the prints to the steel mill, and all the beams are made exactly in the size and shape we need. Every piece is numbered when it is delivered at our building; and so all of them may easily be sorted out and lifted to their proper places. Then the riveters begin to put all the thousands of beams together as the frame mounts up into the sky. And the steel worker, high up in the air and on some days lost in the mist as he keeps his balance on a girder, has one of the most exciting of all trades.



Photos by Structural Slate Co

In a modern slate quarry, where the age-old rock is taken from the ground, a wire is used for cutting down into the stone. This leaves a smooth, clean surface. Blocks weighing six or seven tons apiece are then cut and wedged out of their resting place, as shown in the topmost picture. Next they are hoisted by chains to the top of the quarry, where they are sawed up into the desired lengths and split to the desired thickness. This is easily done, for slate splits naturally, and the workers are so highly skilled that they have no trouble in splitting a large block, as shown in the center picture, into slabs only the thickness of a blackboard. After the slate is split, its surface is smoothed and finished in various ways till the slab is ready for the purpose it must serve. In the lowest picture is one of the carborundum machines by which slate is shaped when its surface is to be beveled or curved.

Making Stone to Suit Our Needs

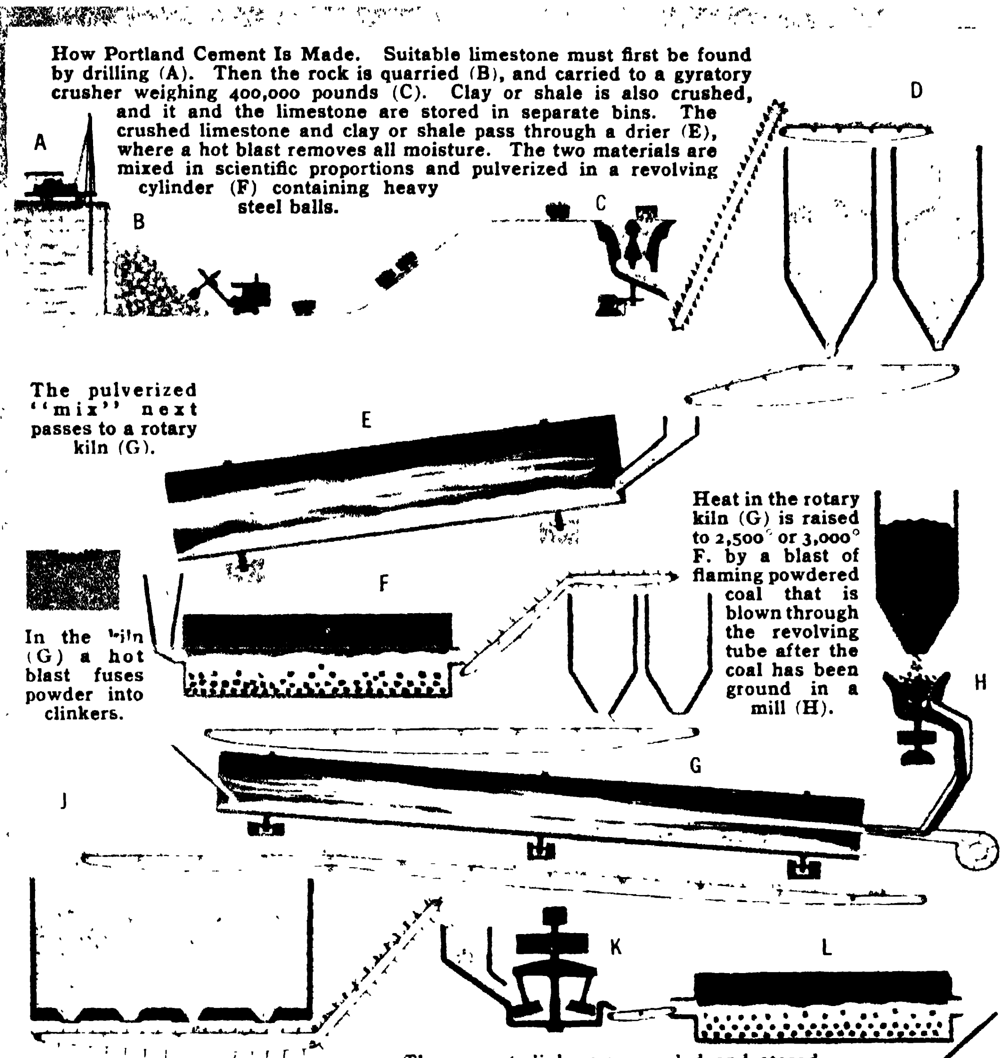
And steel is used in other forms besides big beams. In most of our fireproof buildings the floors are held up by thousands of small steel rods that run from column to column. These rods are all buried in the cement, or "concrete," that makes the floors, but it is the rods that keep the concrete from breaking up under its load. For concrete is very strong if it has something to rest on, but it will break in two if it is only stretched through the air between two columns; so then it needs the steel rods to hold it up.

Concrete is a stone that man himself has made. When we need it we mix up a lot of sand and gravel and cement with water, and pour the mixture into moulds of the desired shape. In a few days the mixture is as hard as stone, and the blocks are ready for the builder.

Natural stone needs to be cut and shaped, but concrete gets its proper shape as it is made. We can even make a whole building out of concrete in one solid piece—walls, floors, and roof. And we often put up buildings in this way, such as factories and warehouses. But in almost all big buildings the foundations and the floors are made of concrete.

Of course the sand and gravel and water would never stick together and make stone

How Portland Cement Is Made. Suitable limestone must first be found by drilling (A). Then the rock is quarried (B), and carried to a gyratory crusher weighing 400,000 pounds (C). Clay or shale is also crushed, and it and the limestone are stored in separate bins. The crushed limestone and clay or shale pass through a drier (E), where a hot blast removes all moisture. The two materials are mixed in scientific proportions and pulverized in a revolving cylinder (F) containing heavy steel balls.



The pulverized "mix" next passes to a rotary kiln (G).

In the kiln (G) a hot blast fuses powder into clinkers.

Heat in the rotary kiln (G) is raised to $2,500^\circ$ or $3,000^\circ$ F. by a blast of flaming powdered coal that is blown through the revolving tube after the coal has been ground in a mill (H).

The cement clinkers are cooled and stored in bins (J). Then gypsum is added, the mixture is ground in centrifugal mills (K) and in ball and tube mills (L), and it is loaded into sacks for shipment (M). Each sack is automatically filled by means of machines that force 94 pounds of cement through a self-closing valve in the bottom of the sack.

Below is a view of a cement plant.

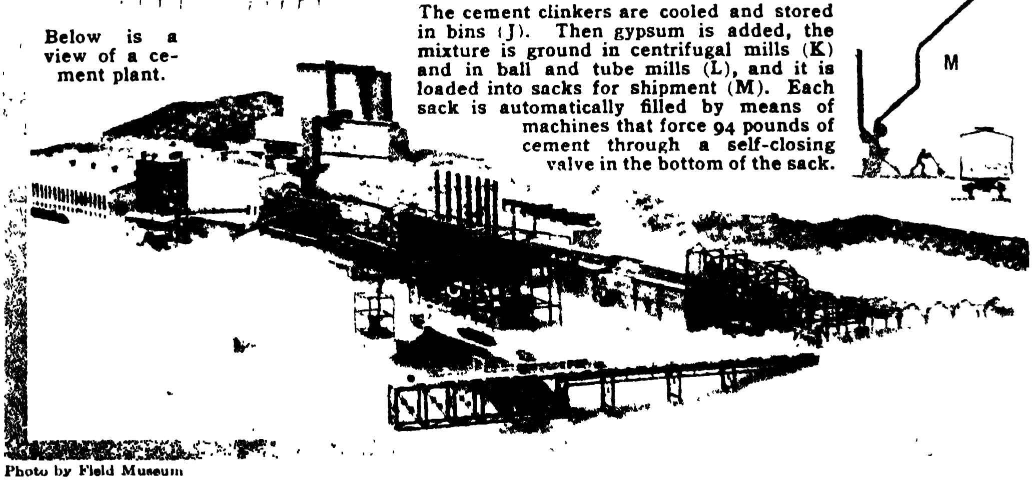


Photo by Field Museum

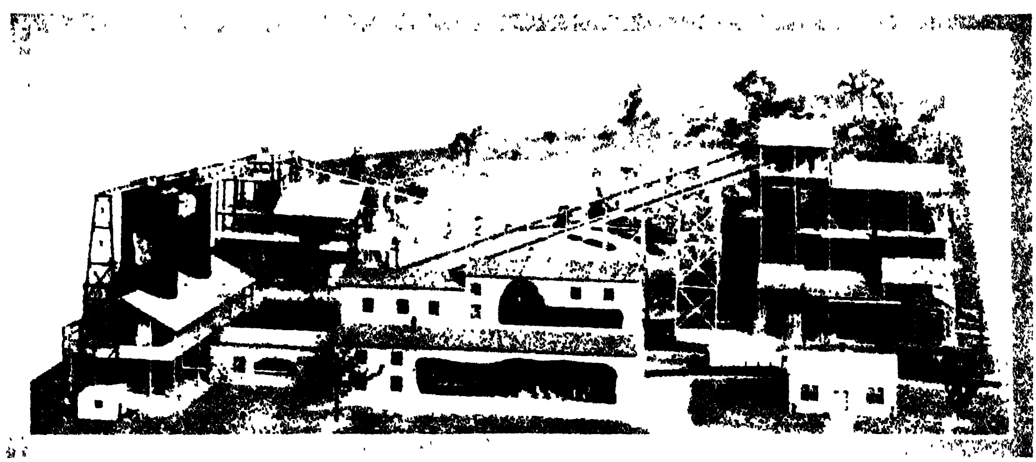


Photo by National Museum

This is the way a lime factory would look if we could take pieces out of its walls to see what was going on inside—for it is a model that is shown in the photograph. Limestone, which was made ages ago from the shells and skeletons of very tiny marine animals, is crushed and burned in a kiln till it gives up part of its substance. What is left we call "quicklime," a material used in making plaster and mortar.

all by themselves. It is the cement that holds and hardens them. Long ago the Romans had a kind of cement and used to make concrete—the best that we have ever seen—but after their day the world forgot all about it. Only a little over a century ago the secret of cement was found out again, and a great industry in it was begun. In the United States alone we make many millions of barrels of it every year.

Our modern cement is a powder made of clay and lime. The lime may come out of oyster shells, chalk, limestone, or various other things with lime in them. The clay and lime are heated in a special kiln until they nearly melt. They come out in clinkers, and are then broken up into the powder we use.

Photo by National Museum

When we are going to plaster a wall we nail up narrow strips of wood or metal, called laths, with a narrow space between strips. Then the plaster is applied to the surface of the laths. It sinks in between the strips, and when it hardens, it holds tight to the laths. This sectional view of a wall is cut down through the lath so that you may see the plaster face securely anchored in the spaces between the laths.

Even with all these materials, we should still have pretty poor houses without glass and plaster to let in the light and to make the walls white and smooth.

Of the two, plaster is much the older. It was in use four thousand years ago in the pyramids. If you watch a plasterer at work to-day you will notice that he puts on three coats of his material. The first two are pretty rough, but the last one, made of different materials, is smooth and white. For the first two coats are made of gypsum (jĭp′sŭm) mixed with sand and wood fiber, while the other is made of fine lime mingled with a little plaster of Paris.

Gypsum is a mineral that is usually whitish as it comes out of the earth. Plaster of Paris is gypsum that has been specially heated, dried, and powdered. When we add a little water to it, we have a plaster which may be moulded to any form we like, and which will dry and harden in about ten minutes. The mouldings on our ceilings and other decorations in large halls are commonly made out of plaster of Paris.

We have a kind of plaster to use even on the outside of a house. It is called stucco.

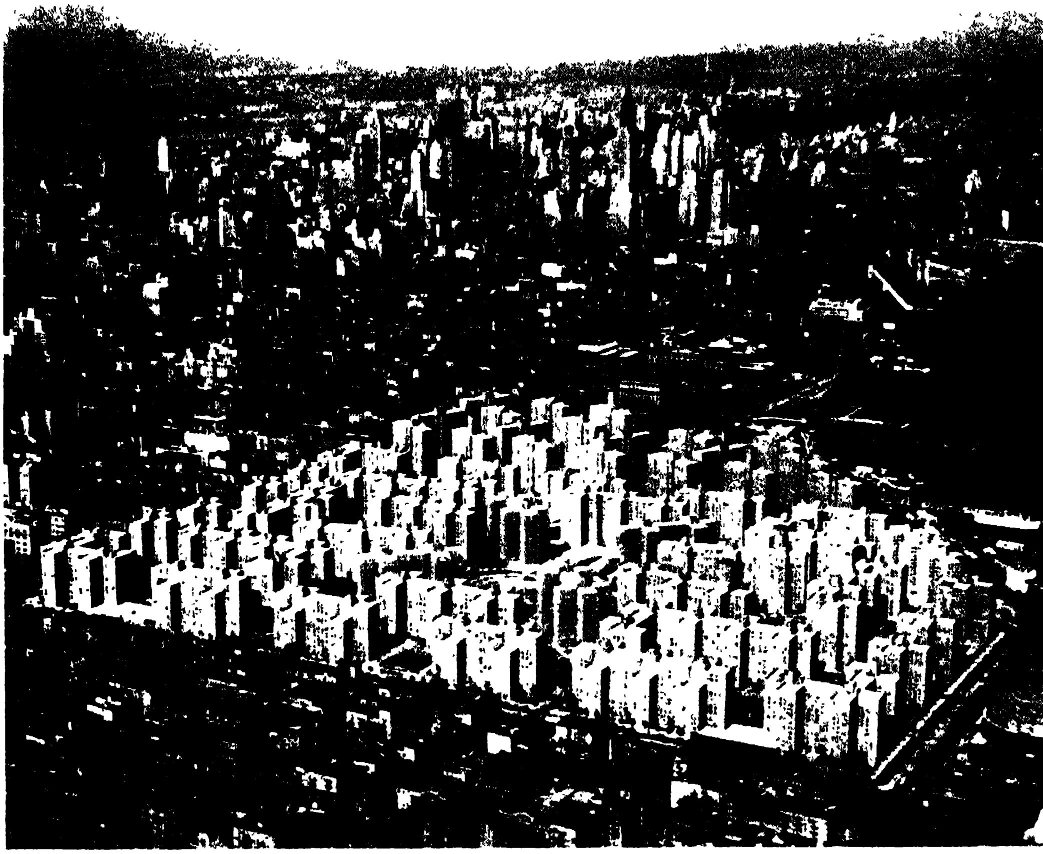


Photo by Thomas Airviews for Metropolitan Life Insurance Company Housing Projects

Building materials are now more costly than they have ever been in history. But scientific planning and mass production have made it possible to turn crowded slums into airy comfort in the modern low-rental housing development shown in the foreground above. Over eleven thousand families enjoy its parks and recreation areas.

It usually is hardened by the addition of cement, and may be colored a beautiful tone.

Glass is very old too, and beautiful things were made out of it long ago in Egypt; but its use in windows such as ours is pretty modern. We have used it in that way only for some four centuries, and even now most of the windows in China are filled only with oiled paper.

Glass is mostly made of a substance called silica (sĭl'ĭ-kȧ), which we can get from common sand. It is mixed with lime, soda, salt, and other chemicals, and melted in a furnace for about sixteen hours. It can then be blown into great bubbles. For common window glass we blow an enormous bubble out of thirty or forty pounds of melted glass, and then cut the bubble open to let the glass flatten out on a table. It makes a great sheet, which is then heated and heated again before it is ready to be cut into standard sizes for our windows.

The plate glass that we see in large windows is not blown in this way, but is poured out on a great, smooth table in a rough sheet. When it has cooled, this is smoothed and polished by being turned around rapidly against sand and emery polishers. Of course glass bricks are now used in walls and elsewhere. And window glass can be made in layers to keep out heat and cold.

Besides the things we have mentioned there are many others -wire, nails, plastic fittings, metal locks and hinges, wire screening, cork, rubber, and asphalt. New combinations of old materials have been invented to take the place of plain cement and stucco for outside walls or of wood or slate for

shingles. We even use paper in building for wallboard and other purposes

There are many materials for insulation (ĭn′sů-lā′shŭn)—that is, to keep out heat and cold. We have for instance, rock wool, made of lead or iron slag melted under very high temperatures and then run in a stream through a steam jet. The force of the hot jet turns the molten slag into a kind of spray that hardens into silky fibers. Other insulating materials are glass wool, asbestos, and a kind of plastic foam seven times lighter than cork and able to keep out sound as well as heat or cold. Glass blown up to a foam, like soap bubbles, keeps out heat, cold, moisture, fire, and vermin.

Many of the new materials are very clever For instance, there is plywood our old friend wood, to be sure, but oh! how different. You may read of it on other pages We can now give wood all sorts of new characteristics, can make it weatherproof and very strong and hard, and can mold it to many shapes.

By using various new cements and plastics we can "bond" rubber, cloth, leather, wood, and plastics to each other or to metal to make a substance even stronger and more lasting than the original.

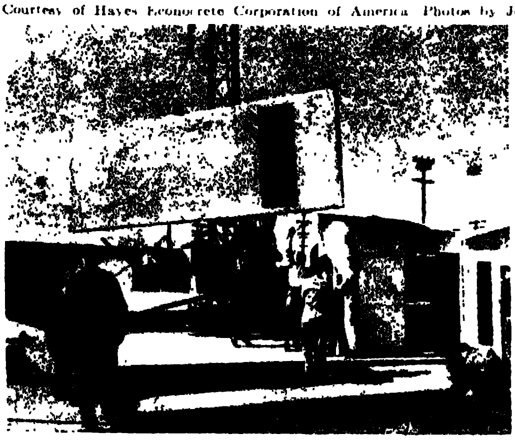
Modern builders are using more metals stainless steel, aluminum, and the very light and strong magnesium alloys. These metals are often bonded to plywood as a facing for walls. Aluminum may take the place of iron and copper around windows and for trim. Many of the new materials and many new uses for old materials were worked out under the stress of war and are proving useful in peacetime

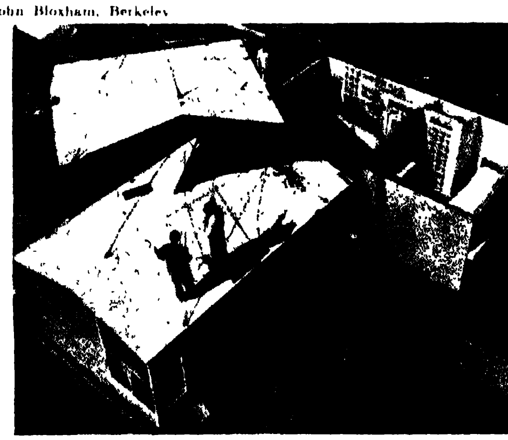
Most amazing of all are the new ways of putting a house up A prefabricated (prē-făb′rĭ-kā′tĕd) house that is, one made at the factory—is shipped in sections that merely have to be fitted together. A four-room house of this kind can be put up in a day. It does not have a wooden frame, as other houses have The walls, complete with doors and windows, come in sections that interlock and fit into grooves in the floor, and the roof is set down on top

The materials are strong but light The wall is thin, and is made in three layers The middle one gives insulation and the other two are of some strong, light material perhaps plywood There are other cheaper hard-surfaced materials to serve outside, with washable wallboard inside Houses that are not prefabricated are often made of such paneling bought in large sheets and then sawed up and fastened to a supporting framework set up by a carpenter Since ceilings and roof do not rest on inner walls, the inner walls of the rooms can be moved about, and the whole floor plan of the house changed to suit the owner's fancy It seems so simple that it reminds one of the days when one built castles out of blocks on the floor

Below, a prefabricated house, delivered complete from the factory, is going up before our eyes. After the floor is laid, the walls are lowered into place as is shown at the left. Notice that the door has been built in, ready for use. At the right the roof here in three sections is being lowered into place.

Courtesy of Hayes Econocrete Corporation of America Photos by John Bloxham, Berkeley





Reading Unit
No. 1

THE BRIGHT QUEEN OF THE METALS

Note: For basic information not found on this page, consult the general Index, Vol. 15.

For statistical and current facts, consult the Richards Year Book Index.

Interesting Facts Explained

For how long a time has silver been in use? 9-388

Which are the two largest silver mines? 9-388

Mining silver under water, 9-389

Working silver into useful articles, 9-389

Silver in photography, 9-389

Sterling silver, 9-390

Why silver tarnishes, 9-390

Things to Think About

Why is silver expensive?

Where is most of the world's silver found?

Why are other ores as important as silver in silver mining?

How are objects covered with a protective layer of silver?

Do you consider silver as beautiful as gold? If it is not, why should platinum be more fashionable than gold for jewelry?

Related Material

How is silver used in taking pictures? 10-449-51

How did the Egyptians use silver for mirrors? 12-80

How has the idea of free coinage of silver affected the history of the United States? 7-292

What is German silver? 9-420

How is stained glass made with the aid of a silver salt? 12-74

What are famous examples of work done in silver? 12-84-92

What happens to silver when it is mixed with gold? 9-306

How is silver used in the thermos bottle? 1-400

Practical Applications

How is silver used in medicine? 9-380

How is silver used in making films for your camera? 9-389

Leisure-time Activities

PROJECT NO. 1: Expose and develop a film in your camera. 10-449-51.

PROJECT NO. 2: Show that sulphur tarnishes silver. 9-390

Summary Statement

Silver is an important metal because it can easily be flattened and worked into useful articles and can be used in the production of silver salts for photography and medicine.

Courtesy Australian News and Information Bureau

Under these interesting structures lies one of the most famous mines in the world. The Broken Hill Mine in Australia has yielded lead, zinc, gold, copper, and silver the last, one of the most important products of all.

The BRIGHT QUEEN *of the* METALS

We Make Silver into Money And, Amazingly, We Also Make It into Pictures and Medicine

THE brightest of all metals is the one that we have chosen for our dimes and quarters. And of course it is no novelty, because we usually have a little of it in our pockets.

But while we know silver so well, we must not think it is any too easy to find We have to do a great deal of hard work to get it out of the earth. To be sure, it can be mined in many places, and it has been known to man for a long time. It was one of the metals he had learned to use before history began. If we could go back for thirty-five centuries or more we might see rich Chinese drinking out of silver cups. Three centuries before the birth of Christ we should find the Romans fighting fiercely to snatch some silver mines from Carthage. And four hundred years ago we could have seen the Spaniards in Peru enslaving the poor Indians and putting them to work getting silver out of the ground for the enrichment of their conquerors.

In those days silver started many a war and struggle Even seventy-five years ago the men who ranged the western mountains in the search for gold and silver were rough old customers, ready for any trouble that turned up To their lot it fell to find the second largest silver mine on earth. They were looking for gold in Nevada, and silver is very often found along with gold

Now Nevada is a dry place, and the men were digging a well for water At the bottom of the well they struck more than water they found a vast lot of gold. After a time the gold gave out, but then the miners began to find silver So that well turned into the famous Comstock mine, out of which has come about half a billion dollars worth of silver. The Veta Madre mine near Guanajuato, Mexico, has outdone it, however.

Silver is found everywhere in sea water, as is gold, but in such small quantities that there is no use in trying to extract it. But in one place, under Lake Superior about a

mile from the Canadian shore, there is a great deal of silver in the ground beneath the water. To mine it there, men have to build great breakwaters and cofferdams, and to sink shafts as deep as a thousand feet beneath the waves.

Where Our Silver Comes From

Most of our silver now comes from the New World. Mexico is in the lead, and the United States follows; together they yield about two-thirds of all the silver that the world produces. South America and Canada come next. In Europe the metal is found mainly in Germany and in Spain. And it is mined in many other places—in India and Japan, in Australia and South Africa. The whole world produces between two and three hundred million ounces in a normal year.

Rarely is the white metal found in a pure state. Though it is one of the chemical elements from which our world is made, it usually comes mixed up in some such mineral as galena (gȧ-lē′nȧ), and has to be crushed and melted out. And often there is so little that it does not pay to mine the silver by itself; that is why the miners look for ore with lead and copper in it also.

Photo by I

Silver is found nearly everywhere in the world, and in backward countries the mining and working of it still are very primitive. Here is a Malay silver worker.

In many ways our silver is of use to us. Second only to gold, it is the most malleable (măl′ē-ȧ-b'l) and the most ductile (dŭk′tĭl) of all metals—that is, it can be flattened out into the thinnest sheet or drawn out into the longest wire. A single ounce of it can be spun into a wire so fine as to reach as far as three miles. It is a very soft metal, however, and is far more useful when mixed with a little copper. Then it turns hard but remains workable; and that is the form in which we commonly see it.

Odd Uses for Silver

It will carry heat and electricity better than any other common metal. If we pour boiling water into a glass, we shall shatter the glass; but if we put in a silver spoon, the spoon will take up some of the heat so fast that the glass will not crack. And the metal picks up an electric current quite as eagerly. So silver wire is excellent for carrying electricity, and it is very lucky that silver can easily be spun into a wire.

Long ago, before we could do much with glass, a queen or any other very fine lady might possess a polished silver mirror. She could see her face pretty well in it—as we can now in a polished spoon. For centuries silver has been made into dishes, jewelry, and ornaments of many sorts, and many of the old products of the silversmith's fine art are very beautiful and very valuable. An ancient saltcellar or teapot may sell for many thousands of dollars to-day.

A great deal of the silverware we now use is only plated with silver. For silver, as it will mix well with many other metals, can also be easily spread or plated in a thin sheet over other metals. The plating is done by electricity. We hang a brass spoon or dish and a piece of silver in an acid bath, and pass an electric current from the silver through the bath to the article to be plated. The electricity spreads particles of silver over the dish or spoon in a thin, smooth layer that hides all the brass beneath.

A Metal We Use for Medicine

Silver is also used in taking pictures, for the camera film is coated on one side with silver chloride (klō′rīd). There would be no photograph without it. And silver is even used for medicine. One of the first things that ever happened to you, just after you were born, was that the doctor put a drop of nitrate of silver into your eyes. You have probably had a sore throat painted with it, and you may have got rid of a wart with it; some day you may stop a boil with it.

It seems to have only one fault. It will tarnish, or turn black, if you let it alone. It turns black whenever it picks up a little sulphur from something around it—and there is often more sulphur around than we know about. If you do not wash your silver spoon after you eat an egg for breakfast, the spoon will soon be black—from the sulphur in the egg. But of course a little cleaning will restore the silver to its bright lustre.

Silver in money has very little chance to tarnish. It is kept bright by the thousands of fingers that handle it. They wear it down, too, so that a coin will sometimes grow quite smooth if it is not taken out of circulation when it begins to get battered and shabby. In order to make them wear better our silver coins are one-tenth copper, for the addition of copper makes silver much harder.

It is a curious fact that the silver in a coin is really worth a good deal less than the coin itself. The market price of silver may vary greatly, but a normal price for pure silver as it comes from the mine is seventy-five cents an ounce troy. Now a dollar contains only a little over seven-tenths of an ounce of pure silver, worth about fifty-two cents in ordinary times. So there is little danger of our melting down a dollar to get the silver in it!

"Sterling" silver is what we usually think of as pure, or "solid"; we use the term for metal that has been made up into useful articles. But it is not absolutely pure; if it were, it would be too soft to wear well. Every ounce of sterling silver is .925 silver and .075 something else. The word "sterling" comes originally from the name of a very old English silver coin, but now it is the term used for the standard of British coinage. A "pound sterling" is the unit of British money, and is normally worth $4.86⅔ of United States money. So when we see the word "sterling" on the bottom of a plate or the back of a spoon, we know that the article is made of silver of the same purity as a British silver coin—though as a matter of fact the British pound is coined in gold, and silver is used only for smaller coins, such as "half crowns" and "shillings" and "sixpence."

Because sterling silver is always of unquestioned quality, we use the word to express solid worth in other ways. So we speak of a man of "sterling character," and mean that he is all that is fine and honest.

About a third of all the silver in the world is made into money, for gold and silver are the best things for coins. Long ago the wise men used to try vainly to make gold out of cheaper metals. Of course they never succeeded. But there is at least one way in which it can be done: put your dimes and quarters into a good bank, and some day they will turn into gold!

Reading Unit No. 2

THE YELLOW SANDS OF RICHES

Note: For basic information not found on this page, consult the general Index, Vol. 15

For statistical and current facts, consult the Richards Year Book Index.

Interesting Facts Explained

What part has gold played in history? 9–392
Gold in California. 9–393
The Klondike. 9–393
Placer mining. 9–393-94
Refining gold from rocks. 9–394
The gold dollar. 9–394-95
Green and white gold. 9–396
24-carat gold. 9–396

Things to Think About

Why is gold mining now a big business?
Why are the chimneys of gold refineries carefully swept?
How has gold affected law and order in the United States in the past?
What makes gold useful?
If man could suddenly multiply his supply of mined gold by ten, would he be ten times richer?

Picture Hunt

How is gold mined? 9–395
Where was gold first discovered in California? 9–393

Related Material

How is gold used in mosaics? 12–112, 11–79
How much gold did ancient Egypt possess? 5–12
How is gold used to keep goods moving from one country to another? 7–510-14
How is gold used in weaving tapestries? 12–144
What is meant by the "gold standard"? 7–342, 507
What is gold leaf? 12–80, 9–396
How are objects plated with gold? 12–89-90
Who are the famous goldsmiths of history? 12–88

Practical Applications

What are the everyday uses to which gold is put? 9–394
How is gold used in sign making? 9–396

Leisure-time Activities

PROJECT NO. 1. Get some gold leaf and use it to make a sign on a piece of glass. 9–394.

PROJECT NO. 2: See how thin you can beat a small piece of scrap gold. 9–394.

Summary Statement

Gold is valuable because it does not tarnish in air or water and can be beaten very thin or drawn very fine. Because it is lasting, and somewhat hard to get in large quantities, it has made a very good basis for money.

Off to the hills where gold glimmers in the river sands! Will they "strike it rich," or will they, like so many before them, grow old and shriveled in the useless search?

The YELLOW SANDS *of* RICHES

The Gold for Our Money and Our Jewels Is Hidden Away in Rocks and Rivers That Keep Calling Men to Come and Risk Their Lives to Find It

"THAR'S gold in them hills, stranger," says the old miner. And those few words are enough to put a new light in men's eyes. Gold! It means dark forests and rushing streams and digging in cold water to find the glistening grains. Gold! It means braving hardship and toil, cold and heat, to try one's luck with Fortune. Gold! It means adventure and a fight with men and Nature, with maybe a nugget of nothing for us in the end, and maybe a stack of gleaming yellow dust. There has never been a time in history when the magic whisper of gold did not steal men's wits away and send them to grub and die, perhaps to steal and kill, in order to get a little of the cold yellow stuff that is so useless and yet so powerful.

Far back in 1200 B.C. a band of rough and shaggy Greeks set out to seize gold from the miners of Armenia, who used to wash it out of their sands in sheepskins. The expedition came to be called the search for the Golden Fleece, and in time it turned into a famous myth. But there had been real gold and real sheepskins just the same. For even in that far-off time—and long before—men had begun to be greedy for the gleaming metal. It was mined in Egypt, in India, and in Rome.

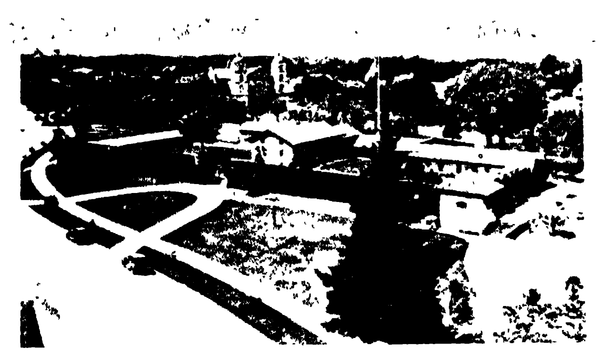
It was partly the hope of the gold that sent Columbus on his uncharted voyage across the western ocean; and it was gold, in such heaps as they had never seen before, that brought the greedy Spaniards after him to the Isthmus and Peru. They did not have to mine it. They merely stole it from the Indians, who had already gathered it in tons and stored it in their courts and temples.

We do not know how much those robbers took away to Europe. They first captured the Inca, or chief, and got 17,500,000 dollars worth at one swoop as a ransom. And after that a steady stream of ships went laden back to Spain with more and more of it. There had not been more than 225,000,000 dollars worth of gold in the whole of Europe; so Spain soon became the richest nation in the world.

And other nations, just as greedy and plundering, could not bear to have it so. The English, and other countries as well, had a steady industry that consisted of lying in wait for the rich Spanish galleons and robbing them of their treasure. The buccaneers who did the job swarmed on the Spanish Main for some two hundred years.

The Forty-niners

The fit of madness came on men again in 1849. Gold had been found in California. From the ends of the earth men swarmed to wrest it out of the streams and mountains. Anyone could come and dig for it. Ships that sailed into the harbor of San Francisco were deserted by their men and officers, who went to hunt for gold. Great covered wagons toiled painfully across the continent, each trying to beat the rest and be the first in the field. The drivers fought the Indians and they also had to fight the more deadly enemies of thirst and hunger and weariness, but on they came across the plains, a steady, devouring stream.



by Visual Edu

This is Fort Sutter, where James Marshall brought for testing the nugget of gold which started the great gold rush of '49. He had picked it up in the race of a sawmill he was building, and his housekeeper had boiled it all day in lye to see if it could really be gold. It was, indeed!

Camps, Cabins, and Pistols

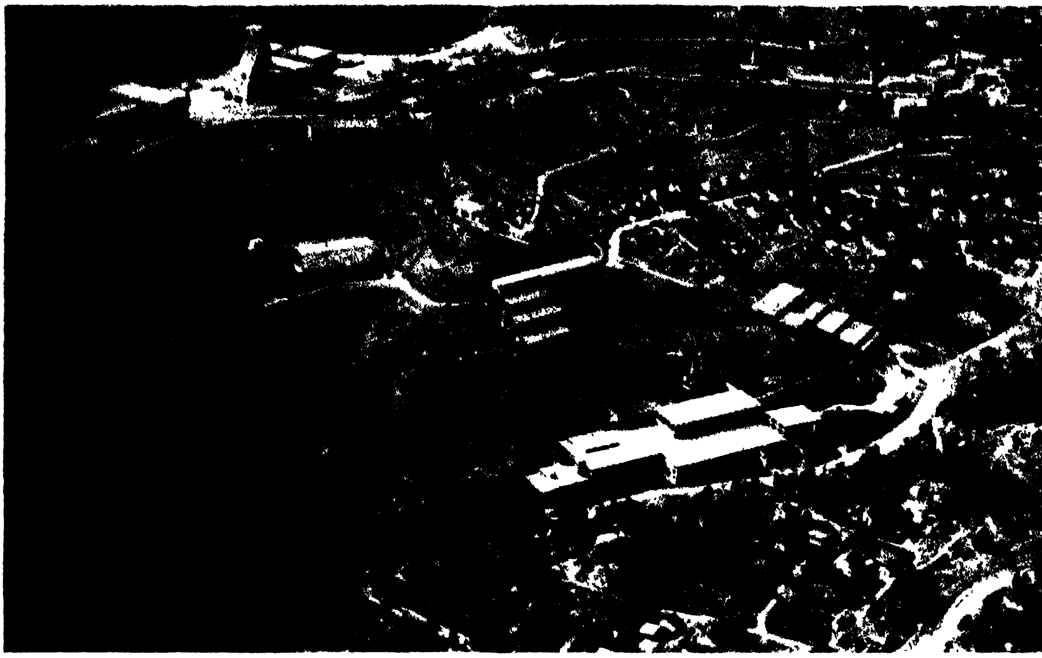
All a man had to do was to stake out a claim. By right the United States government owned all the gold in California, but the miners took the law into their own hands and set up their own rules and regulations. Rough camps and cabins sprang up, and bearded men kept order with pistols and guns. A man could put up stakes around a small piece of ground of his own choosing and then he would have the right to all the gold he might take out of it. But he had to keep other people off—and he carried a pistol to do it! There was no other law; there were no police or soldiers.

And what enormous quantities of the yellow stuff there were to bewitch men's minds! In the twenty-five years before the California gold rush only 8,000,000 dollars worth of gold had been mined in all the world. But 127,000,000 dollars worth was mined in the twenty-five years that followed. And figuring the price of gold to be about $20.67 an ounce, it would work out to nearly two hundred tons.

There have been other gold rushes since those days of '49, but none have matched it for excitement. In 1896 gold was discovered in Alaska and Northern Canada, and the Klondike rush began. In the Klondike the bitterest enemy was the cold, but the men struggled over ice and snow, with frozen hands and feet, to stake out a claim. Many died of cold and hunger, thousands more found nothing and lost their all, but some few came back very rich.

That was the last big gold strike. To-day the mining of gold is a business—a very big business, with over a billion dollars' worth of gold mined in a normal year. Most of it comes from South Africa and Siberia, for Russia now ranks second or perhaps even first. She does not reveal her production. Canada and the United States come next. No more can the old-time miner have the thrill of taking a pan, wading out into a stream, and washing out the precious yellow sand.

Washing gold out of a stream is called placer mining. Gold is very heavy, and when the sand and gravel that held the precious grains were washed in a pan, the gold sank to the bottom and the sand ran over the edge of the pan. Sometimes a miner was lucky enough to come on a little lump, or nugget. A nugget found in 1869 and



Courtesy Homestake Mining Co.

Here are the surface plants of the Homestake Mining Company in South Dakota. Homestake mines and mills a million and a half tons of ore every year. It is the largest producer of gold in the Western Hemisphere.

known as the "Welcome Stranger" weighed 2,520 ounces. But such luck was rare.

In the placer mining of to-day large dredges dig up the bottom of a stream and the gold is washed out by machinery. Sometimes the gravel banks along the shore are washed out by a powerful stream of water that is played on the loose pebbles and then sent through long sluices. For nowadays very few wash out gold in a pan; it is too slow and uncertain. Much of the gold produced in the United States comes from mines worked mainly to get other metals.

Whenever gold is found in the sand of streams or buried under them, it means that rocks in which the gold was hidden have been washed away by tireless little rills and spread in layers where the waters flowed. For gold is scattered in very tiny quantities through nearly all the rocks. It is even found in sea water—very little in a given gallon, but sometimes as much as a grain to a ton of water, and perhaps ten billion tons of gold in all the oceans of the world. No one has ever found a paying way to get it out.

Gold that is taken from the rocks themselves is often found in streaks called veins, or lodes. Into such a vein a shaft is sunk through the surrounding rock and the gold-bearing ore is taken out. The gold is usually perfectly pure, but is scattered in tiny flakes or grains through the body of the rock.

It is nothing for our great machines to crush the ore, wash it with deadly cyanide of potassium (sī'ȧ-nīd of pô-tăs'ĭ-ŭm), separate the gold by electricity, and get nine-tenths of the metal from the rock. But in years gone by, a man thought he was doing very well indeed if he got half of the metal out of the rock.

The modern mine does not waste gold. Even the chimneys in refineries are swept to get back the gold that has been evaporated when the metal was well above the melting point, which is 1,945° F.

What a Gold Dollar Is Made Of

Gold is used for money, and is also made into many other things—jewelry, table ware, teeth, paint, lettering; one could name a great many articles. At present our government is not making gold money and allows none to be in circulation. Pure gold is very soft—too soft to be really useful but it

Photos courtesy Australian News and Information Bureau, National Film Board, Homestake Mining Company

The old prospectors at the top left are panning for gold just as the people did who rushed to California in 1849. Gold-bearing earth which has been loosened by pick is washed in the shallow pan. Because gold is very heavy it stays in the bottom of the pan as the lighter sand and dirt float away. To discover how much gold each ore contains, samples are melted in a furnace like the one at top right. This is part of the process called assaying. Much more gold is mined than is found by panning. One of the world's largest gold mines is the Homestake Mine in South Dakota. Its shafts drop more than a mile into the earth. Here you see part of the enormous hoisting equipment which is needed to handle the miners and the precious ore of the Homestake lode.

Photo by Railway Express Agency

Very few pictures are left of the California gold rush. This interesting old photograph shows one of the early miners selling his gold at a Wells Fargo stage office. The ever-present pistol is close by the scales.

becomes much harder when certain other metals are mixed with it. So copper, some eight or nine per cent of it, is added when we make gold into money—and then the gold's pure yellow takes on a reddish tinge. And silver and copper are added if we make it into dishes. Twenty-five per cent of silver makes the "green gold" we see in jewelry, but a little more silver than that makes a white alloy, or mixture. Twenty-five per cent of platinum makes the "white gold" of the jewelers. And if we add some twenty per cent of aluminum we get a fine purple alloy, which is not very useful because it is too brittle. Very thinly divided gold has a reddish tinge, so it goes into ruby glass. It is even used in treating arthritis.

We tell the amount of gold in a mixture by measuring it on a scale divided into twenty-four parts. Each part is called a carat. When gold is marked "twenty-four carat," it is pure gold. But eighteen-carat gold is only three-fourths gold—there are eighteen carats of gold to six carats of something else. And twelve-carat gold is only half gold. This is worth remembering whenever you buy a ring or a watch.

In many ways gold is a wonderful substance. It never changes in air or water, and so can never rust. It can be beaten thinner than any other metal; a single ounce is said to have been pounded so thin that it covered three hundred square feet. And an ounce is a very small lump, too; a cubic inch of gold weighs nearly three-fourths of a pound. For gold is exceedingly dense; it weighs 19.3 times as much as water.

Gold can also be drawn out thinner than almost any other metal. A lump no larger than a pea has been made into a wire some two miles long.

The fact that gold can be beaten so thin and that it will not rust makes it the best metal for several purposes. "Gold leaf" is used in a great many different ways. We see it everywhere—for instance, in signs and lettering on shop fronts. The sign maker sticks pieces of gold leaf against the glass or wood and then cuts out the letters.

But the thing that makes gold so valuable is not that it can be used. Iron, lead, and copper serve a great many more purposes. We set a high price on gold mainly because it is so hard to get. If it lay all about in the streets it would cost no more than sand or stone. Because men have agreed to call it valuable, they spend their lives to get it. And then they often wish they did not have it. Before World War II Uncle Sam acquired nineteen billion dollars' worth of the world's gold, and stored most of it at Fort Knox, Kentucky But because we had it, other nations did *not* have it to buy our goods with--and we had no way to use it.

Reading Unit No. 3

STRENGTH OUT OF THE EARTH

Note: For basic information not found on this page, consult the general Index, Vol. 15.

For statistical and current facts, consult the Richards Year Book Index.

Interesting Facts Explained

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Why is iron really worth more than gold?
Why is iron the world's most useful metal?
Why can the United States produce half of the iron and steel of the world?
Why should nations go to war over the possession of iron deposits?

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PROJECT NO. 2: Make a model locomotive, 14–549.

Summary Statement

Iron is the most valuable metal because it is found almost everywhere, and because it can be changed into a large number of useful articles without a great deal of trouble.

Photo courtesy Iron and Steel Institute

Three fountains of shooting sparks mark the spots where hot saws are cutting a 120-foot rail into lengths needed by the railroads. The rail is glowing hot when it rumbles out of the many rollers which shape it.

STRENGTH OUT *of the* EARTH

The Story of How We Find Our Iron and How We Make It into Steel

WHAT is the best of all our metals? Is it precious gold? Or wonder-working radium? No, luckily the rare things in the world are seldom the ones that we need most. Useful as our gold and radium are to us, we could still get along well enough without them. But we could hardly get along without our iron. We make so many things out of it, and put so much of our work upon it, that we could not live our present lives without it. If we did not have it, we might still be about where we were before the days of Abraham.

There are many reasons why iron is so useful. In the first place, we have plenty of it. We have found it nearly all over the world; so the metal that we most need is the one that we can get almost anywhere. And then we can do more with it than with any other metal. We can make it harder and stronger than any other common metal, and give it a sharper edge. Yet when we soften it with heat, we can hammer it out into any shape we like—which is to say that it is malleable (măl'ê-à-b'l). Or we can draw it out into a rod or wire, which is to say

that it is ductile (dŭk'tĭl). When we heat it white-hot, we can hammer two pieces of it into one, or weld it. If we raise it to about 2,700° Fahrenheit, we can melt it. And then we can mix in a little of various other metals to make it just what we want it.

So we do so much with iron that we call our era the Iron Age. Thousands of years ago man made all his rude tools—hammers and axes and other things—out of stone. That was the Stone Age. Then he found out about copper and tin, and put them together into bronze. As long as he made his tools with bronze he was in the Bronze Age. Even then he used the iron found in meteorites. Finally the ancient Hittites learned to mine iron, and as the knowledge spread men entered the Iron Age—in which we have lived for at least 3,000 years. The vast improvement in all the things that we now make of iron, from our needles to our ocean liners, tells the tale of its importance.

We were saying that there is plenty of iron in the world. In fact, the earth seems to be mainly made out of the metal, for the great molten center underneath the thin crust of the globe would seem to be almost entirely iron. That, of course, is too far down for us to use. But right on the surface, or a little way below it, there is enough iron to last us for a long time.

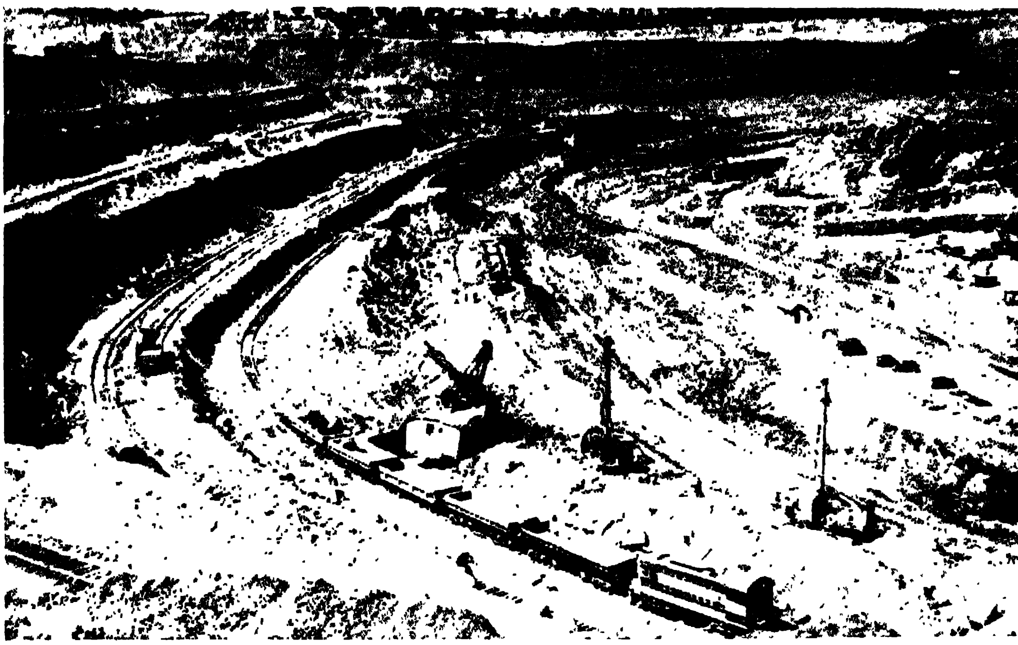
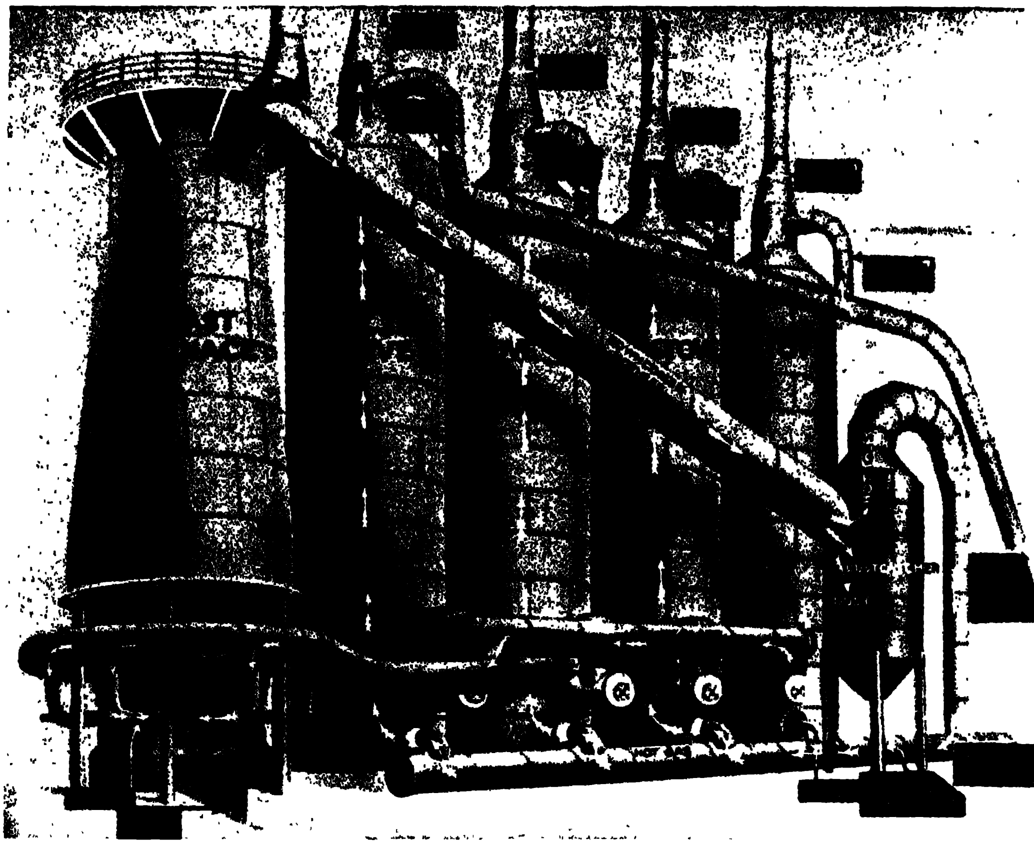


Photo by Roleff, courtesy Iron and Steel Institute

Here in Minnesota Mother Nature has spread out her precious iron ore close to the surface of the earth. All the miner needs to do is to break it away with power shovels and load it into the flatcars drawn into the mine by the locomotive you can see at the bottom of the picture. The work goes on night and day in order to feed the hungry blast furnaces of the steel industry. As the digging gradually lowers the floor of the mine, new spur tracks follow the mining shovels to untouched deposits. When the great Mesabi Range was discovered, the customary way of iron mining was to sink a shaft into the earth so that the miners could go underground and dig out the ore. A foreign mining engineer who came to supervise the mining of the Mesabi's rich ore indignantly refused to have anything to do with a "mine" which allowed men to stand in the sun and scoop up ore with shovels. "No shaft—no mining!" he exploded, and went back home. Other men went ahead and shoveled up the ore from what proved to be the richest iron ore deposit in the United States.

We never see it really pure, except perhaps as a curiosity. The silvery white metal—for that is the color of pure iron that has not gathered a brown coat of rust—always contains certain impurities. It usually comes out of the ground mixed with other things, in what we call iron ore. Sometimes the ore is so near the surface that we can dig it up with steam shovels, and sometimes it is so deep that we have to go far underneath the ground to mine it. But always we have to melt the ore before we can separate the iron, which even then is not pure.



Courtesy American Steel and Wire Co

The iron must be melted out of the ore in gigantic blast furnaces, in which a blast of hot air fans the fire to a terrific heat. Here on the left is a furnace—with its bank of four "stoves," where the air that is to be driven through the furnace is heated. The inside of each stove is divided by walls of fire brick into a central flue with a number of vertical chambers around it. Hot gases given off by the blast furnace are driven into the large pipe, called a "downcomer," which carries them to the dustcatching chamber where they are freed from dust. At the bottom of the stoves you can see the pipe which bears the dust-free gas to the stoves, in which it circulates until the bricks are hot. Then it will pass up one of the tall chimneys at the top of the stoves. Now a damper shuts off the gas and cold air is pumped into the stoves through the large pipe near their top. It circulates through the heated chambers of the stove, becoming very hot by the time it is driven through the tuyeres (twē'yâr'), or nozzles, into the bottom of the blast furnace. The engines that pump the air also get their heat from hot gas from the blast furnace. While air is being pumped through one stove, another is heated with gas; so there is never a break in the hot blast blown into the furnace. This is absolutely necessary, for once a blast furnace is started, the heat must be kept up night and day or the furnace will be ruined.

This we learned to do a long time ago. It is hard to guess how long ago, because all the first things we made out of iron must have long since rusted away. But we have found an iron blade in Egypt that seems to be about five thousand years old. And we know that a little later the Egyptians, and the Greeks and Romans after them, used a good deal of iron and also knew how to make it into steel.

The Discovery of Iron

The use of it must surely have been found by accident. Somewhere a man had made a very hot fire against a hillside full of iron ore; and when the fire died away, the man found a chunk of iron he had melted. Doubtless this happened in a good many places before some genius saw that he could melt the ore whenever he wanted to, and get a metal far harder and more useful than the bronze that he had been employing. That was the first dawn of the Iron Age. And since then we have gone on mining and melting more and more iron, changing it into more and more forms, and making more and more things out of it—until we now use it for such things as suspension bridges four

miles long and buildings over a hundred stories high. We could not make these with any other metal.

For many a century, of course, the fires and furnaces we built to melt iron were fairly simple affairs. It was hard to heat a fire hot enough to do the job, and two or three hundred pounds of iron made a large amount to melt and handle. Until we had modern machinery, it was slow and costly work to change our iron ore into a metal we could use.

Now we melt and work it in vast quantities and far more rapidly, to turn out all the things we need to make out of it. For this purpose we commonly use an extremely hot fire in what is known as a blast furnace. A blast furnace is a tall steel tower lined with fire brick a kind of brick that will stand a great heat without melting. The furnace is filled with alternating layers of coke, iron ore, and limestone. Then a blast of very hot air is forced through the burning coke, making it seethe with an intense heat Of course this melts the ore, and the iron flows to the bottom of the furnace. A large furnace will hold almost seven hundred tons. About every four hours the molten iron, still far from pure, is drained off.

Courtesy United States Steel Corporation

Every four or five hours the pool of iron and slag in the blast furnace is tapped by burning out a plug with an oxygen blowpipe. The metal to be used for steelmaking runs down a trench into great ladles which will haul it away. As it comes from the blast furnace it is called "pig iron." The early method of casting was to run the metal into molds fashioned in a bed of sand near the base of the furnace. A trench was cut in the sand for the iron to flow through, and from it extended dozens of smaller trenches in a position like that taken by a litter of suckling pigs. The main trench was called the "sow" and the smaller trenches, "pigs." Notice how the tapper shields his face from the intense heat.

Out of the molten metal we can make three main things, which in turn have several varieties. We can make cast iron or wrought iron or steel. Cast iron and steel can be made directly from the molten metal.

Cast iron has too much carbon mixed with it to be malleable. It is usually gray and very hard, but also very brittle. We cannot beat it into shape, but we can pour it into molds to harden into fifty-ton machinery parts or countless lighter objects. Wrought iron has far less carbon and can be turned into any shape we like. But we make very little of it, for it is too soft for all ordinary purposes, especially for bearing heavy weights, as in our railway tracks, bridges, and tall buildings. For these and many other uses we want steel—the hardest and strongest and most useful product we make out of iron.

Steel is a special form of iron, usually with some carbon left in it and often with a small amount of some other metal, such as nickel, chromium (krō'mĭ-ŭm), or tungsten, which helps to harden it. It may be hard enough to cut wrought iron, just as iron can cut bronze, and it will take an edge like a razor. It has an enormous strength, but it is spongy rather than brittle, and at a high heat it may be given any shape we like. And because it is so very useful we have found need for the United States alone to produce more than 90 million tons of steel every year.

When we drain the molten metal out of a blast furnace we have what is called "pig iron." Sometimes it is shipped while still molten, but usually it is cooled—or "cast"—into ingots (ĭng'gŏt) in molds. The molds are

This is what happens inside a blast furnace, where iron is taken from the ore. As shown in the vertical section at the right, the blast furnace is a huge chimney lined with fire brick, which can resist great heat. Into the top of the tower are dumped carefully measured loads of limestone, coke, and iron ore, brought up from the ground in bucket cars. A blast of hot air blown in at the bottom of the furnace raises the temperature of the furnace to terrific heat, as shown by the figure given along the left side of the diagram. As the raw materials sink lower in the furnace they become hotter and hotter until they finally melt. The substances in the coke and limestone gather the impurities in the ore, and the pure iron is left. Since this is heavier than the other substances, it sinks to the bottom of the furnace, where it can be drawn off into pig molds. The impurities are drawn off as molten slag, which can be used later on to make cement. The gases that are given off when the limestone, coke, and iron ore are raised to white heat are piped back to heat the air blast at the bottom of the furnace. At the left is the enormous scoop which gathers up enough ore or coke in one bite at the stock piles to load a bucket car. The scoop is electrically operated and can be quickly shifted on overhead tracks to any part of the stock pile yards.

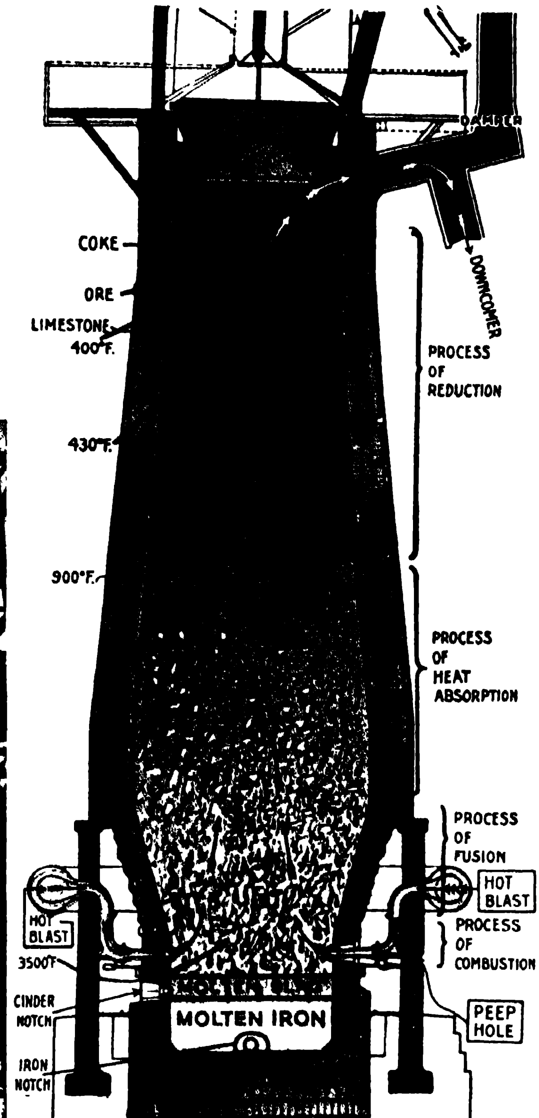


Photo courtesy United States Steel Corporation

Courtesy United States Steel Corporation

The pear-shaped bowl at the left is a converter in blast, which means that a great jet of air is being blown up through the molten metal in the converter. When the process is finished the metal is tough and malleable.

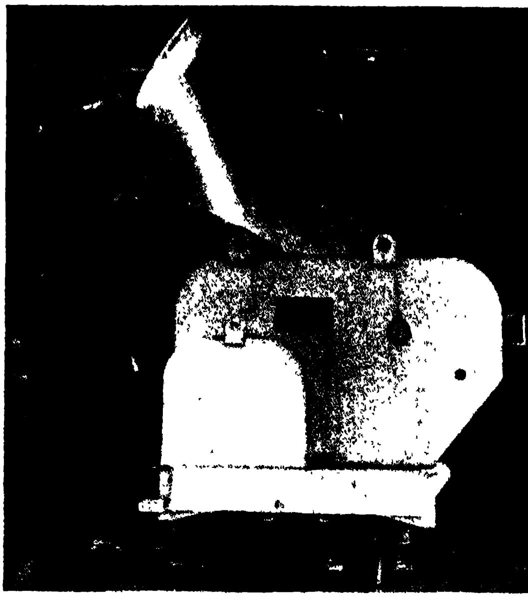
generally made of cast iron and are open at both ends. When ready to be filled they are placed on heavy cast iron plates, called "stools," which stand on small railroad cars. About 70 ingots can be cast in one mold before the mold must be scrapped and used in charging another furnace.

By a process known as "puddling" this cast iron may be made into wrought iron. The cast iron is melted again, together with some additional iron ore, and the mass is stirred until the carbon and certain other ingredients are removed. Then we have wrought iron. This is almost the pure metal, and it is still the best thing we have for many purposes. It is the kind of iron a blacksmith uses, because when he has heated it red-hot he can beat it into various shapes.

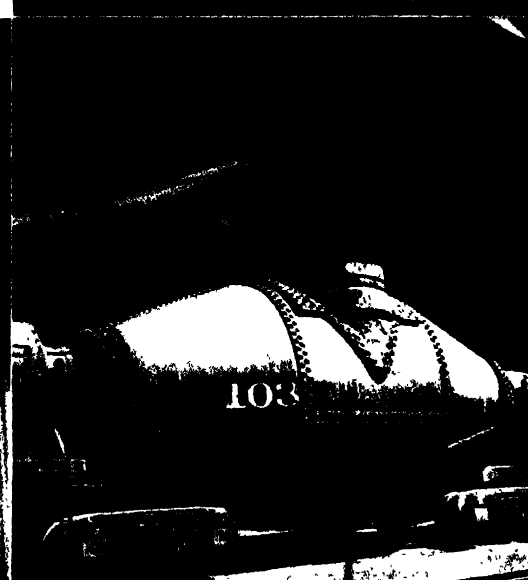
But most of our iron is now made into steel. For many centuries we had known ways of making steel, but only in fairly small amounts. The early railway tracks were therefore made of wrought iron, and until about the time of our great-grandfathers fairly little steel was used. It was only about a century ago that we found out how to make steel easily enough to furnish millions of tons every month.

It may be made directly from the molten iron that runs out of the blast furnace, or from the cool pig iron molded from this. There are two main ways of making it—the Bessemer process and the open-hearth process—and adding vanadium (vȧ-nā′dĭ-ŭm), molybdenum (mô-lĭb′dê-nŭm), manganese, cobalt, or other metals will vary its qualities and suit it for widely different jobs.

The first process is named for an English inventor, Sir Henry Bessemer (1813-1898). He invented a good many different things, such as a stamp to prevent forgery of important papers, and a way of making the



The metal flowing from mixer to ladle, above, is so hot that the apparatus is operated by electricity from an air-conditioned room, called a pulpit. At the right another type of ladle, used for casting metal in ingot molds, pours from the bottom to prevent the floating slag from entering the mold.



The ingots at the left are the first solid form which steel takes. When the metal has cooled in the molds, they are stripped off the ingots by a pair of powerfu' fingers which grasp lugs at the top of the molds while a plunger holds down the ingot. Above is one of the inclosed cylindrical ladles which will transport 160 tons of molten metal from the furnace to the open hearth.

Courtesy United States Steel Corporation

Photo courtesy American Iron and Steel Institute

As you can see in this picture, open hearth furnaces are charged with hot metal. The ladle has been filled from the storage mixer and carried overhead on its giant hooks to the door of the furnace, where its contents are poured into the furnace through a portable funnel. Besides the molten metal which you can see here, the charge of the furnace will include carefully controlled amounts of such elements as carbon, manganese, phosphorus, and sulphur. Open hearth furnaces are so named because the hearth or floor of the furnace is open to the sweep of the flames which purify the metal. A saucer holding 250 tons of metal rests over air and gas chambers made of fire brick laid in a checkerboard pattern. The combined air and gas raise the temperature to 3,000° F. and drive off all impurities. The refined steel is drawn off at the rear into ladles.

lead we use in our pencils. But his great invention was his method of making steel. When he first proposed, in 1856, to make steel without burning any fuel, some of the engineers thought he must be joking. But they soon found he was starting a brand-new age of steel.

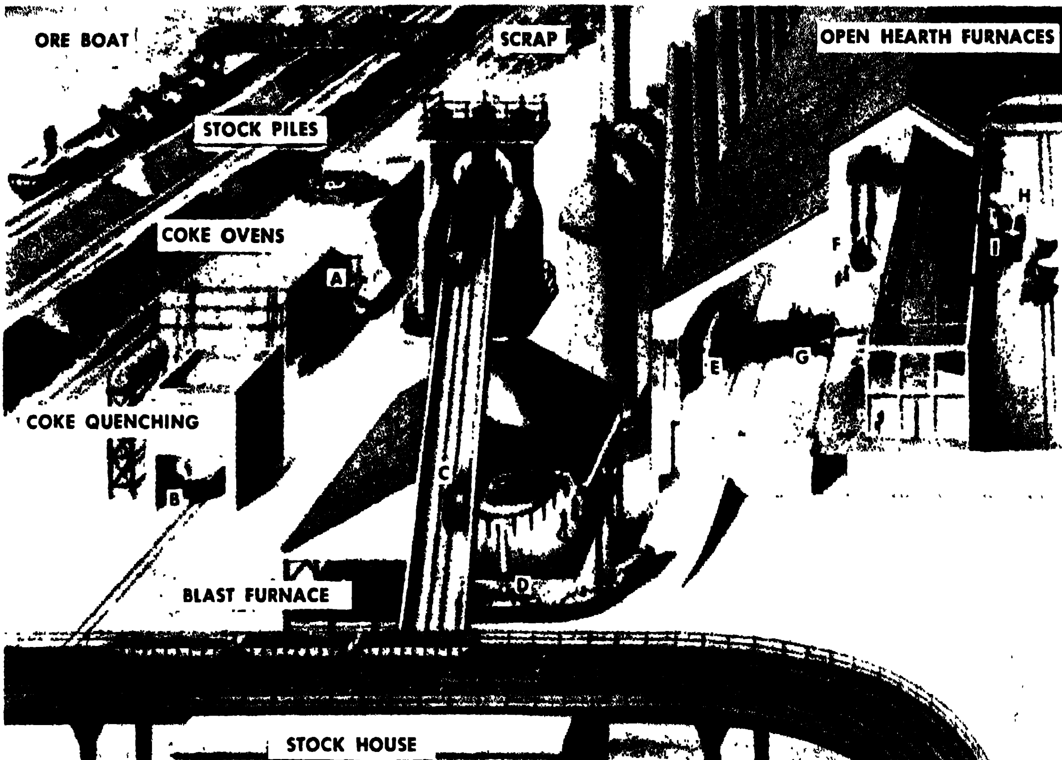
The Chief Ways to Make Steel

In the Bessemer process we run molten iron into a huge "converter," which hangs on pivots and has an open mouth pointing upward. Then we blow a great blast of air up through the molten mass from the bottom. Instead of cooling the mass, as might be expected, the air heats it all the hotter by burning out the impurities in it. And while the process lasts, we have a magnificent shower of sparks from the mouth of the converter. But it is all over pretty quickly, for we can make steel in this way in about twelve minutes. To be sure we get it just right, we can stop the process at any point and test a small sample of the mass.

In the open-hearth process we run the molten iron into a shallow pan or hearth, made out of brick, and let certain gases sweep over it at an intense heat until the impurities have been burned out. This takes a good deal longer, but it makes much better steel and is the method most commonly used.

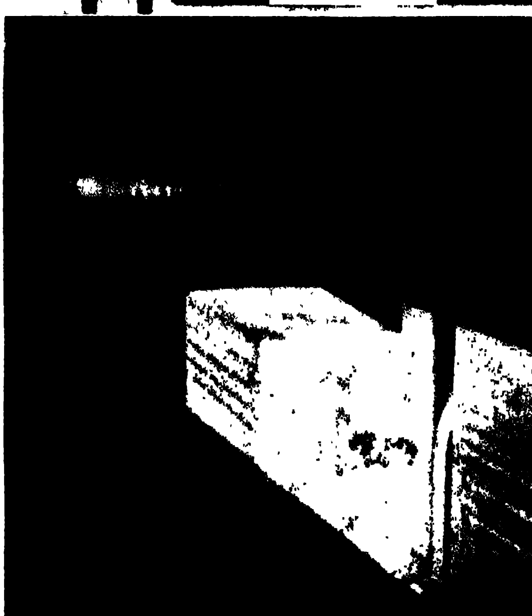
A certain amount of steel, of finest quality, is now made in electric furnaces where melting and refining can be most closely controlled. Instead of coke, the electric furnace is heated by carbon electrodes.

But how can we, from a mass of molten steel, make rods and beams for bridges and skyscrapers? First the steel is put under enormous pressure to remove any remaining impurities and to squeeze out the holes that may develop in it in the same sort of way



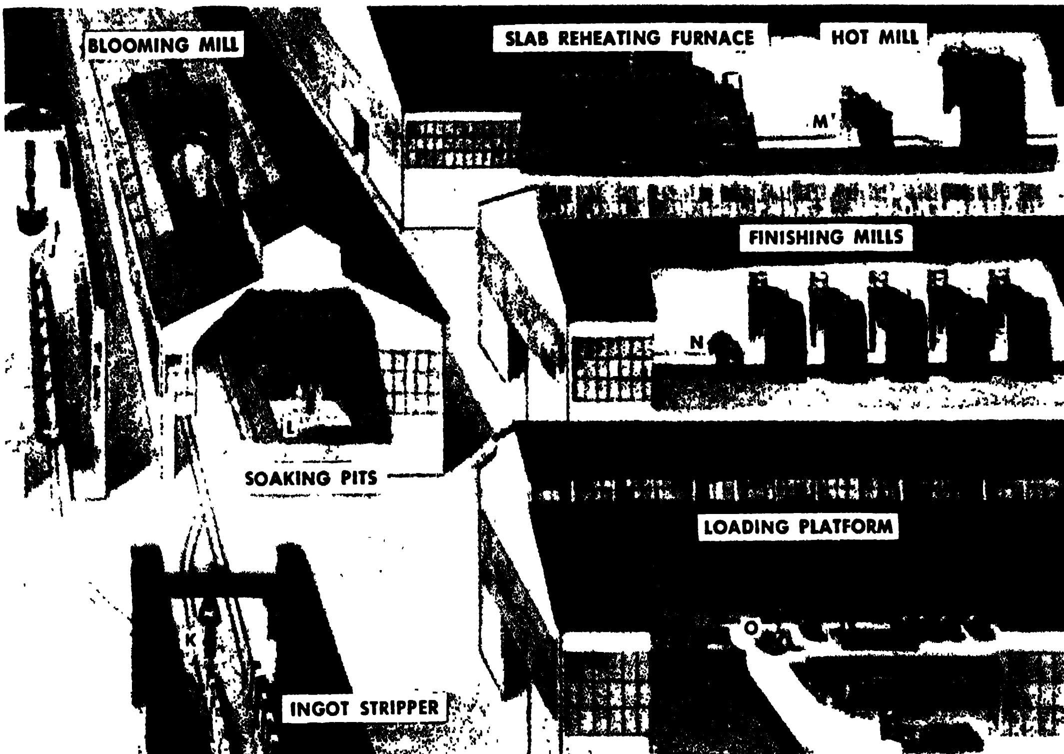
Drawing courtesy American Iron and Steel Institute

This drawing shows a plant which includes all the operations of steel making. Only about one out of eight steel plants are like this. Iron ore, limestone, and coke coal which has been heated (A) to remove impurities and quenched (B)– are hauled to the top of the blast furnace (C) in skip hoist cars. After five hours of blasting they become molten pig, which ladles (D) carry to the open



Photos courtesy United States Steel Corporation

Steel which will be made into rails is shown above as it enters the rolls of a blooming mill. The chunk of white-hot metal is squeezed and kneaded by rollers to make the "bloom," or slab, thinner and thinner. Then it goes to a roughing mill to be given the T form which you can see in the photograph at the right. Before it can be cut into lengths the rail will go through five more rollings.



hearth furnace. Under careful control (E) the furnace is charged (F) with pig and scrap, handled by a long-arm loader (G). Purified steel flows into a ladle (H) and slag into a "thimble" (I). The steel is cooled in ingot molds (J) which are later removed (K). Ingots to be worked are soaked in heat (L) and kneaded to toughen the slabs, or "blooms." Hot rolling (M) and finishing (N) shape them for shipping (C).

Photos courtesy United States Steel

These photographs show two more products of steel. Seamless pipe is made from a solid block of steel. First the tough steel is softened by heating to 2,200° F. Then it is squeezed by rollers and rolled over a mandrel, or long bar, much as a tight glove is rolled over a finger. This is the process shown at the left. Above, hundreds of steel railroad wheels wait in neat rows for shipment. They must be of a very good grade of steel.

they form in certain kinds of cheese. When it has been thoroughly pressed in this way, it is ready for shaping.

Have you ever seen stick candy made? A lot of candy "dough" is simply forced through a round tube and comes out in a long roll. Before it is quite cool it is cut off into lengths, and these are the sticks of candy that we can buy anywhere.

Of course a thing like steel is very much harder to handle, and takes far more machinery, but the basic process is very much the same. The steel is put through a rolling mill. It is hot enough to be squeezed into various shapes. And if we want to make round rods of it, for instance, we force it by enormous pressure through a very strong round tube. If the rod must be still smaller, we can feed it into another smaller tube; and when it is finally the right size, we can cut it into the desired lengths and let it cool. To temper it we cool it very rapidly.

Of course steel can be beaten or cast into any desired shape or rolled out into sheets of varying thickness, a form in which a steel plant often sells it to manufacturers. Lately ways have been found to make steel articles from ore by one continuous process.

Although iron ore is found in many places, and there are large deposits of the metal in every continent, a large part of the world's supply comes from the United States. About a third of the pig iron in the world is cast in the United States and over half the steel is made there. Since 1875 the United States has produced more than two billion tons of steel. It is estimated that there are more than 23,000 pounds of steel now in use for every man, woman, and child in the country.

About two-thirds of all the iron ore in the earth is found in North and South America. There are large deposits in Cuba, Newfoundland, and Labrador; and far back in the hot jungles of Brazil are the world's largest supplies, which are only now being opened up. In the United States the district around Lake Superior turns out 81 percent of the country's output. But even the famous Mesabi (mē-sä'bē) Range in Minnesota has been drained by two world wars, and the region as a whole is nearly exhausted. It has vast supplies of taconite (tă-kŏn'īt), which contains iron but is not quite ore. Such deposits are very costly to work, but our steel industry is finding ways to overcome that drawback and is looking for fresh supplies.

Miners and manufacturers like to find iron and coal in the same district, for then neither has to be moved to melt the ore. But this is not necessary. In the Lake Superior lands there is a vast business of special trains and boats to carry the ore down over the lakes to the smelting plants. The boats are made so that they can be loaded by machinery in half an hour.

The World's Most Useful Metal

There is hardly any way to list all the things we make out of iron and steel. In very ancient days it was used mainly in war and in hunting, for knives and swords and spears. Later it was made into the armor worn by the knights of the Middle Ages. The Arabs were making horseshoes out of it thirteen hundred years ago, and the Chinese are supposed to have been the first to make needles out of steel. These came into Europe with the Moors around the year 1200. At that time iron was in common use for such things as nails and hinges, and in bars and plates.

When gunpowder came, iron was used for cannon and for firearms. And as the years went on, more and more tools and machines were made of iron. In our own day far more things are made of steel than ever before—railways and locomotives, steamships and automobiles and even airplanes. Nearly everything we eat or wear or use in any way is brought to us or made over for us by machinery, and the machines are nearly all made out of steel. That is why we say we live in the Iron Age.

There is even a little iron in our blood. Very little of it indeed; but we could not get along without that small amount. It comes in many of the foods we eat. And when we do not get enough of it, the doctor often gives it to us as a medicine. We sometimes take it through a tube to keep it from staining our teeth black. But one of the best of all ways to get it is by eating molasses.

Reading Unit No. 4

THE SALT ON YOUR TABLE

Note: For basic information not found on this page, consult the general Index, Vol. 15.

For statistical and current facts, consult the Richards Year Book Index.

Interesting Facts Explained

Things to Think About

Why can we not live without salt?
How does salt help us to freeze things?
Why does not a man's body sink in Great Salt Lake?
How do certain people provide their bodies with the necessary salt, when they cannot get it directly?
Is the use of salt in food a habit, and could we learn to enjoy food without it?

Picture Hunt

Related Material

Practical Applications

Leisure-time Activities

PROJECT NO. 1: Allow some salt water to evaporate in order to collect the salt.

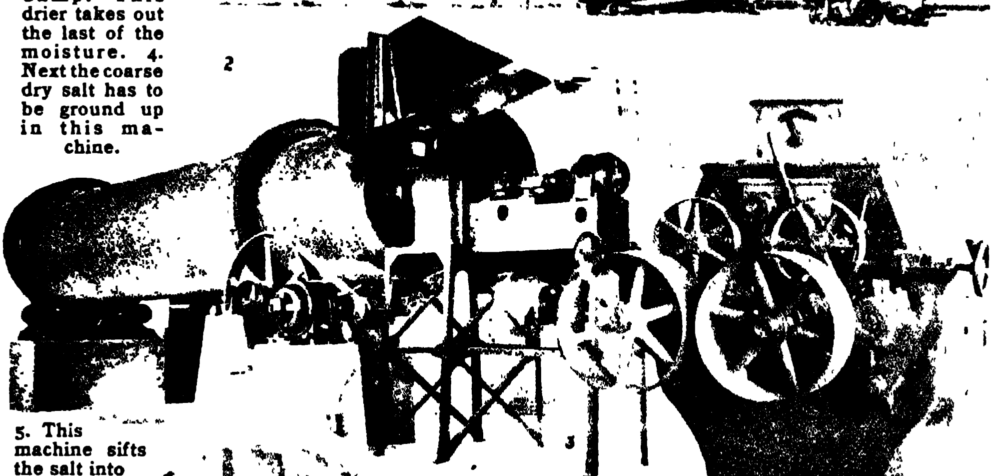
PROJECT NO. 2: Pass an electric current from two dry cells through a glass of salt water in order to decompose the salt.

Summary Statement

Salt, which is necessary for all living things, is found almost everywhere on the earth.

From salt pond to kitchen—on this page you may see some of the steps in the journey. 1. When salt is to be taken from the ocean or some other body of salt water such as the Mediterranean or Great Salt Lake, the water is often drained into vast evaporating pans such as those shown in this picture. Here it lies for several months while the sun does its work. 2. When enough of the water has passed off, great shovels like this one scoop up the salt and pile it in pyramids.

3. When the salt is harvested it is still damp. This drier takes out the last of the moisture. 4. Next the coarse dry salt has to be ground up in this machine.



5. This machine sifts the salt into different grades.

6. And here finally is a girl in spick-and-span overalls putting table salt up in bags for us to buy.

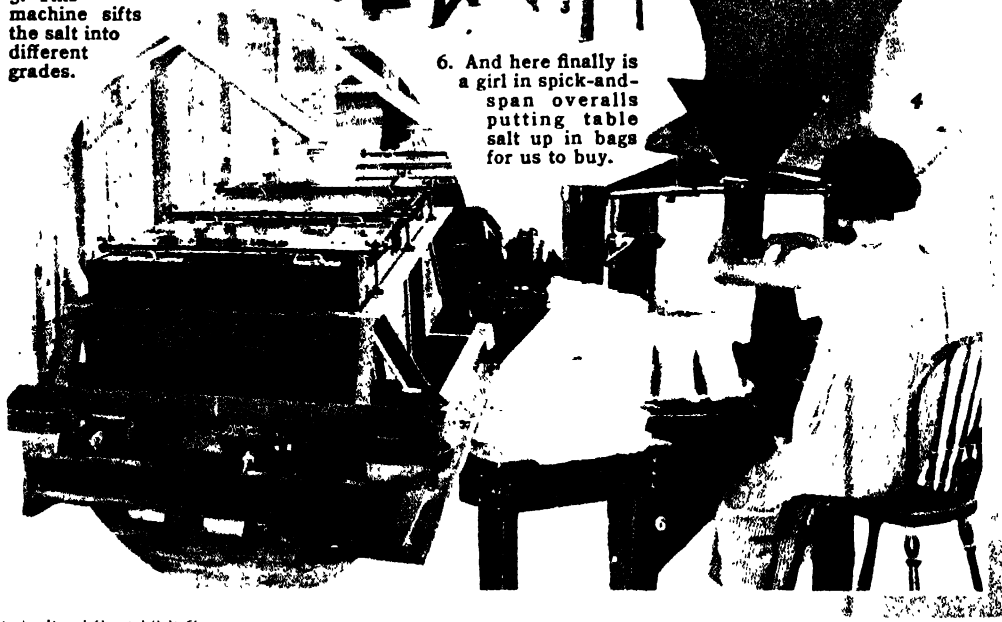


Photo by Royal Crystal Salt Co.

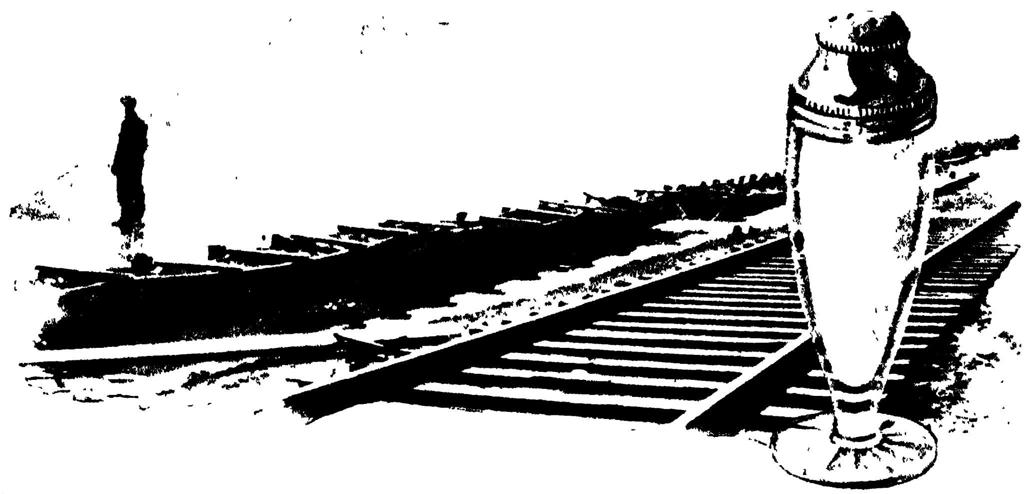


Photo by Royal Crystal Salt Co.

When a certain little boy was asked to define salt he said that it was "the thing potatoes are no good without." Because so many people feel that way about salt, millions of tons of it are every year taken from the briny sea, dug out of the earth, or pumped up from wells. At the left of this picture are great heaps of salt, like little hills, waiting to be taken away and made ready to go into the salt cellar at the right. Near Great Salt Lake in Utah long rows of these storage piles line the glimmering white salt ponds where the briny water has been allowed to evaporate, leaving the pure salt to be "harvested" and shipped away.

The SALT *on* YOUR TABLE

Do You Know How It Got into the Ground Long Ago and How We Get It Out Now?

ALL the water that flows down to the sea is just a little salty, because it takes up a trace of salt out of the ground. The ground has everywhere a little salt in it In the sea the water is much saltier, for there it has been evaporating for millions of years and leaving the salt behind it all the time. Some parts of the ocean are saltier than others. Around the Equator there is more salt than around the poles, and in certain seas that are all but wholly inclosed, like the Mediterranean, there is more salt than in the open ocean. On the average there are about four ounces of salt in every gallon of sea water; and this means that in the whole ocean there is salt enough to cover the entire United States with a layer a mile thick.

Some of the lakes that have no outlet are still saltier than the ocean. The Great Salt Lake in Utah and the famous Dead Sea in Palestine are among the best known. They are so heavy with salt that you cannot sink in them; and when you come out and dry off, you are all crusted in a coat of white. Under the ground in many places there are similar bodies of salt water, or "natural brine."

Now when one of these lakes dries up, it leaves a great bed of salt behind it; and the same thing happens when an arm of the sea is shut off by the land and dries away. The beds that remain are called "rock salt" They have all come down to us from the ages when the world was younger, and of course they are now covered over with soil that has piled up above them. There are great beds of this sort in New York and Michigan and Louisiana; and in Poland there is one that is 500 miles long, 20 miles wide, and 1,200 feet thick.

There are many ways of getting salt out of the earth. In the days of old our ancestors who lived far from the sea might take it from the salt springs which they found in various places, and for which they sometimes fought

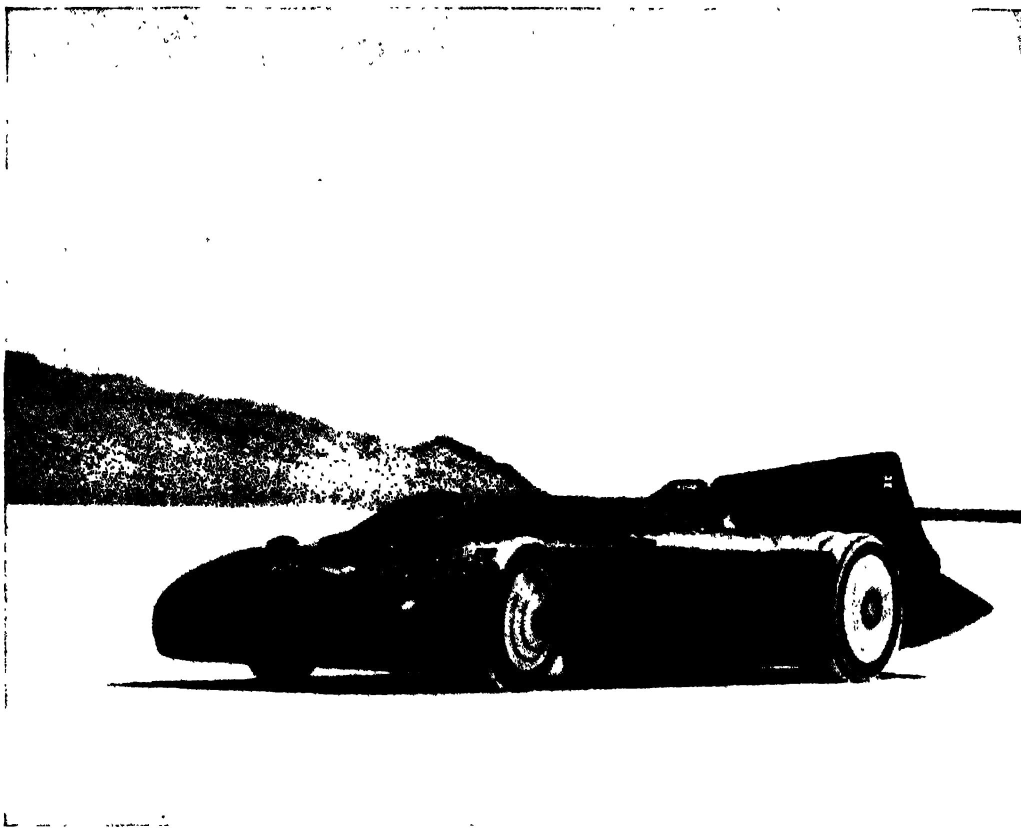


Photo by Keystone View Co.

Many automobile speed records have been set on the smooth, hard-packed salt at Bonneville Salt Flats in Utah, to the west of Salt Lake City and not far from Great Salt Lake. The flats provide an ideal surface for racing cars like Sir Malcolm Campbell's famous "Bluebird," which you see above on a test run. Drivers of lesser fame, too, enjoy going at full speed on the absolutely straight highway which crosses the flats.

each other fiercely. Others used to get it from the salt oases in the Desert of Sahara, as they still do to some extent in our own day. Some of the caravan routes were laid out by men who were toiling over the sands in search of salt; and so were many of the very oldest roads in the world—such as the Roman *Via Salaria*, which merely means Salty Road. Those were the days when salt was precious indeed.

Where Our Salt Comes From

Nowadays it is far easier to get. We may simply evaporate the briniest waters we can find, as in the ocean or the Great Salt Lake, and take the salt they leave behind. Or we can go down into a great bed of rock salt and dig it out in the same sort of way we dig out coal. Sometimes the great white caverns that are carved out in salt mines will gleam like fairy palaces beneath the ground. Or we can get the salt out of these beds without even going down for it. We can send down a stream of water through a pipe into the salt, and draw it up again in another pipe as brine; then we just evaporate it and use the salt it leaves us. In clear, warm lands the sun may do all the evaporating, but in others artificial means are often used. And the whole process is so easy that salt is just about the cheapest thing we eat.

All these ways are still employed to give us our salt. It comes to us from hundreds of places. But the main lands from which we get it are Germany, Italy, Russia, India, China, Spain, Canada, and the United States. In the whole world over thirty million tons of salt are produced every year, and over fifteen million come from the United States—mainly from New York,

Photo by National Museum

A real group of salt wells would not look just like this, of course, because in this picture the walls have been taken off the buildings so as to let us see how things look inside. Here are the steel towers standing over the wells themselves, which have been drilled deep into the rock salt below the surface, much as oil wells are drilled. The great pumps force pure water down into the wells. There it soaks up the salt and becomes heavy brine. Then the pumps draw it up again into storage tanks. After that the briny water has to be evaporated and the salt dried and ground and sorted into different grades.

Michigan, West Virginia, Ohio, Louisiana, Kansas, Utah, Nevada, and California.

We cannot live without salt, for our bodies are like chemical factories, in which salt—which the chemist calls sodium chloride (klō′rīd)—is necessary to carry on certain processes. For instance, it helps in making hydrochloric (hī′drô-klō′rĭk) acid, which is poured into our stomachs to help digest our food. Salt is everywhere in our bodies in our bones and flesh, and in our blood and tears.

Why Salt Makes Us Thirsty

But if we take a good deal of salt at any one time, our bodies cry out for water almost at once. For the blood and all the fluids in which our tissues are bathed get too salty for comfort. Then we feel thirsty, and drink enough water to make our blood less briny. But if we could not do so and had to keep on taking salt, we should finally die. For the very substance that is necessary to keep us alive would kill us if we took a very large quantity of it. That is why a shipwrecked sailor whose thirst drives him to drink sea water only gets all the thirstier for it and dies all the sooner.

How the Savage Got His Salt

In the earliest days our ancestors could get enough salt in the meat they ate, for they never boiled the salt out, but ate the meat raw or, later, roasted it. And even to-day there are people like the Bedouin Arabs who eat no salt except what comes in the milk and meat they take. Some of the savages in Africa who have no salt in any other form grow terribly hungry for it and will gulp it by the handful when they can get it from some rare white traveler.

Many a wild animal will do the same thing. If you are ever out in a great forest and want the deer to come around you, just wedge a hard lump of salt into the cleft of a tree so that it cannot be pulled out; in a few days the deer will find it and will be coming to lick it by the hour. But be careful to lock up anything you have been handling, or you will find that some other beastie has

Photos by Duetschen Museum and the New York Zoo

One would think that the men in the picture above were building a great stone palace, but no, they are only mining rock salt. The largest salt mines in the world are in Poland, where there are salt deposits 500 miles long, 20 miles across, and 1,200 feet thick. At Wieliczka is a vast and weirdly beautiful underground city, with railway stations and houses and chapels hung with gleaming crystal chandeliers—all made out of salt. In this glistening white city people sometimes live and die without ever knowing what life is like on the surface of the earth. Men have been digging the marvelous arched galleries of Wieliczka since the thirteenth century, but the little deer in the lower picture was gobbling salt long before that. Here we see him scraping his tongue on the salty earth of some "salt lick," perhaps by a briny spring in the forest.

gnawed it up in the night—for the salt in it! Have you ever noticed that your finger often tastes a little salty? It is because the perspiration that dries on it leaves a little coat of salt. So when we handle things a great deal—like shoes or saddles, for instance—they also get salty. And then the porcupines love chewing them!

Of course we do far more with salt than merely eat it. We use vast quantities of it to keep our meat and fish from spoiling, for it prevents the growth of the tiny plants and animals that make things spoil. We use it in making glass and pottery, soap and fertilizer, and in many other manufacturing processes. It is a mild disinfectant, and is good for gargling a sore throat or for cleaning the teeth. And it has many other uses. Sprinkled on ice, it melts the ice but at the same time sends the temperature down far below freezing; and in this way it even helps to freeze our ice cream. For the mixture of salt and ice is much colder than ice alone. All this is because salt water freezes at a much lower temperature than pure water.

So precious has salt been to man down through the ages that we have many ancient customs and expressions that rose out of its use. In the ancient East it was a solemn act of friendship to "eat salt" with a man; and it was a scoundrel indeed who could be false to any man with whom he had sat down and taken salt.

The STORY *of* MISCELLANEOUS METALS

Reading Unit No. 5

ODDS AND ENDS AMONG THE METALS

Note: For basic information not found on this page, consult the general Index, Vol. 15.

For statistical and current facts, consult the Richards Year Book Index

Interesting Facts Explained

Metals that float in water, 9-418
The heaviest metal, 9-418
The lightest metal, 9-418
The metal first used by man, 9-418
Tin cans are not made of tin, 9-420
Zinc, 9-420
Aluminum, 9-420-21
Platinum, 9-422

Things to Think About

Why has aluminum become popular?
Why was copper the first metal worked by man?
Why is lead important?
How are copper, tin, and zinc used in industry?

Picture Hunt

How is ore dug out in an open-pit mine? 9-419
How is a copper mine constructed? 9-421

Related Material

Why is copper important to man? 9-418-19
How has aluminum aided the progress of transportation? 9-421
How is tungsten used in electric lamps? 1-535-36
How is tungsten used to harden steel? 1-536
What two metals leaped into fame during World War II and what accounted for their great usefulness? 9-422
How is zinc used in our homes? 9-420
How is mercury used in medicine? 9-416
How is the heaviest metal used? 9-418

Practical Applications

What are the products obtained from lead? 9-418
How are metals combined to form alloys? 9-417, 419-22

Leisure-time Activities

PROJECT NO. 1: Collect and mount samples of the common useful metals, 9-416-22.

PROJECT NO. 2: Make some amalgam by mixing another metal with mercury, 9-416.

Summary Statement

When we think of metals, we are almost sure to think of something hard and heavy. But there are metals which are neither hard nor heavy. Some of them are rarely seen.

Photo by Anaconda Copper Mining Co.

In large mines there are miles of railway running in all directions through the earth at various levels to carry the ore to the central shaft. Sometimes in old mines horses draw the cars, but in this copper mine at Butte, Montana, electric trams scurry about through narrow corridors dimly lighted by electricity.

ODDS *and* ENDS AMONG *the* METALS

See How You Would Like to Try Making a Chain with One Link of Each of the Things Described Here

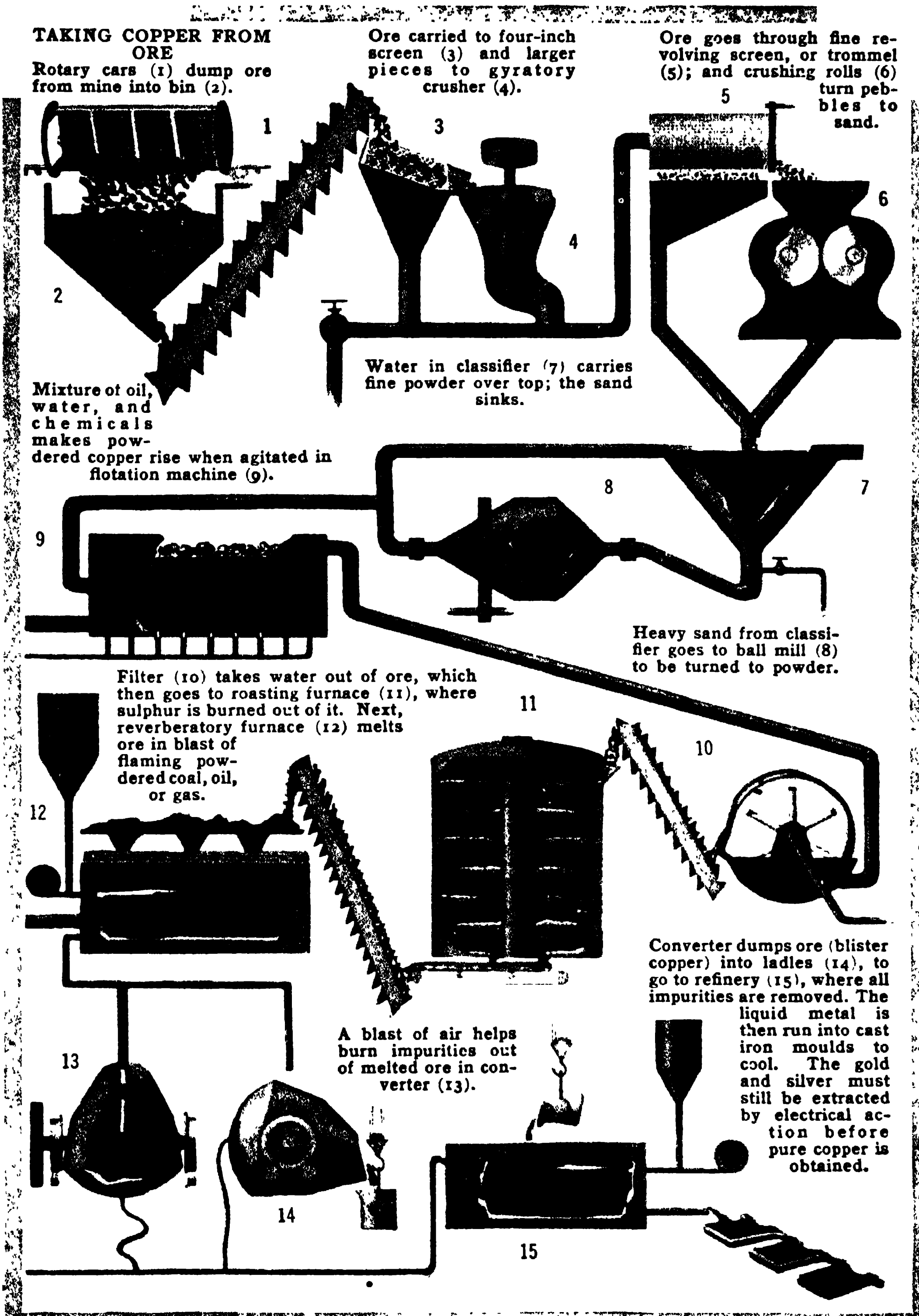
WHEN we think of metal, we are almost sure to think of something hard and heavy. But there are metals that are neither hard nor heavy. Some of them are so light that they will float in water, and some are so soft as to flow around like oil.

For instance, there is mercury. It is never solid unless it is frozen—at thirty-eight degrees below zero Fahrenheit—and even then it is fairly soft. Otherwise it is simply the bright, oily quicksilver that you may have seen pouring out of a broken thermometer and running all over the floor in silvery little globules. You may have found it fun to scoop them up and let them run around in your hand. For though they are heavier than lead, they flow about like oil, but without ever dampening your hand.

We use mercury for many things besides thermometers. We put it on the backs of mirrors to make the bright surface that reflects our faces. We place it in a glass tube and run an electric current through it, then it turns to vapor and gives us the bluish light that we use so much in taking pictures. We use it in many medicines, especially in calomel, and give it for many diseases. And we mix it with various other metals to make up useful amalgams (ȧ-măl′găm)—the name we give to mixtures of mercury with other metals.

Most of our mercury comes from California, where it is found in the mineral called cinnabar. It is mined in Oregon and Nevada, also, and in Italy, Spain, and other lands.

A ball of iron will float in mercury, and also in melted lead. For though lead is about a fifth lighter than mercury, it is still


TAKING COPPER FROM ORE
Rotary cars (1) dump ore from mine into bin (2).
Ore carried to four-inch screen (3) and larger pieces to gyratory crusher (4).
Ore goes through fine revolving screen, or trommel (5); and crushing rolls (6) turn pebbles to sand.
1
2
3
4
5
6
Water in classifier (7) carries fine powder over top; the sand sinks.
Mixture of oil, water, and chemicals makes powdered copper rise when agitated in flotation machine (9).
8
7
9
Heavy sand from classifier goes to ball mill (8) to be turned to powder.
Filter (10) takes water out of ore, which then goes to roasting furnace (11), where sulphur is burned out of it. Next, reverberatory furnace (12) melts ore in blast of flaming powdered coal, oil, or gas.
11
10
12
Converter dumps ore (blister copper) into ladles (14), to go to refinery (15), where all impurities are removed. The liquid metal is then run into cast iron moulds to cool. The gold and silver must still be extracted by electrical action before pure copper is obtained.
A blast of air helps burn impurities out of melted ore in converter (13).
13
14
15

so heavy that a block of it twenty-one inches square will weigh a ton. Yet it is so soft that you can easily drive a nail into it; and you may have melted it, just for fun, over the kitchen stove.

Things We Make of Lead

Lead is found and used all over the world. It is one of the first metals that man learned to employ. It will not rust, and it was therefore used for water pipes in ancient Rome, as also for roofing. And it is still widely used for pipes in our day, remaining one of the chief metals of the plumber. For the painter it is even more important, since the main thing that goes into good paint is lead. In fact, we often use lead without thinking of it or even seeing it. For example, good putty has lead in it, and so has fine window glass. But workers with lead need to be careful, for it is a poisonous metal if they get too much of it into their systems. It is used in a number of ways in medicine.

When we invented guns we made the bullets out of lead. That was because lead is the heaviest of all cheap metals, and the heavier a thing is, once started, the farther it will go and the harder it will hit.

There are lead mines all over the world, though more than a third of the supply comes from the United States. The metal is hardly ever found pure, but is taken out of several kinds of ore, and largely out of the mineral we call galena (gȧ-lē'nȧ).

The Heaviest Metal of All

There are metals far heavier than lead, and osmium (ŏs'mĭ-ŭm) is the heaviest of them all. It weighs just about twice as much as lead, and a cubic foot of it comes to nearly fourteen hundred pounds.

Osmium comes from Canada, Russia, the United States, and Colombia, and is very rare. It is always found mixed with other metals and is by no means easy to handle because it is so very hard. On account of its hardness it is used for things that have to stand a great deal of friction. Thus it was once on the tips of fountain pens, though that is now too costly. In fine clocks and certain other instruments the parts that are always turning against one another may be made of this very hard, enduring substance.

Like some other metals, osmium will burn. When heated, it gives off a poisonous vapor with a very unpleasant smell. Indeed, its very name, coming from the Greek, means "smelly metal."

There is a metal that is only about a fortieth as heavy as osmium, and only about half as heavy as water. This is lithium (lĭth'ĭ-ŭm), which will float in water like a piece of wood. It is a white metal, softer than lead, and it takes fire like paper. It is fairly common but is never found in its pure form. Even when separated, it is not one of our most useful metals. We employ it in certain medicines, and drink it in lithia water; and we have recently found a way of obtaining it so cheaply that we may use it in fertilizers.

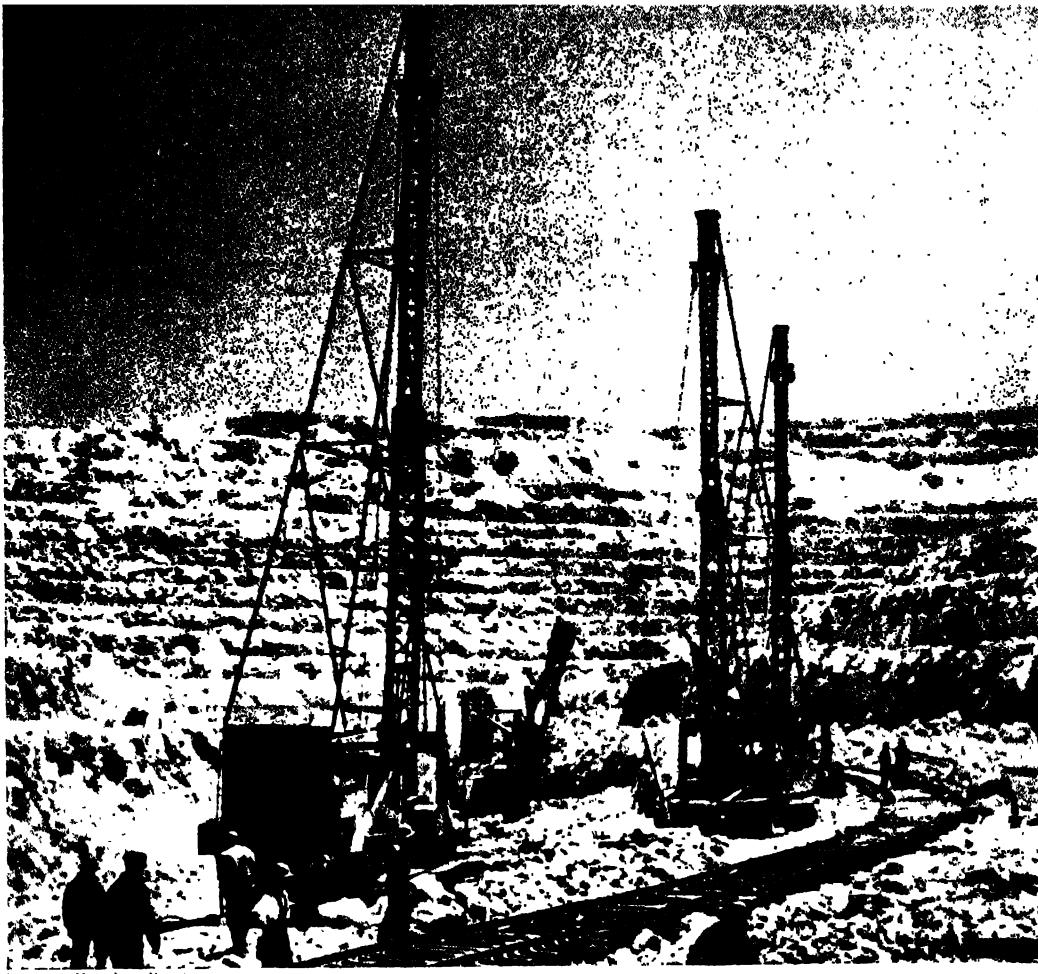
Now we turn to a bright metal that we all know a great deal better. We carry a few pieces of it in our pockets nearly all the time, for it is what we use to make our pennies. In fact, we call a penny a "copper", and that is exactly what the Romans used to call it long ago, though of course they used a different word.

The First Metal Man Learned to Use

But copper was used for many things long before the days of Rome. It was the first metal that man ever learned to use, and was long the most important. Mixed with tin it made an alloy known as bronze; and the early men in history made so many things of this alloy or mixture that their era is called the Bronze Age, for the same reason that our own is called the Iron Age.

Copper is called the "red metal" because it has a reddish hue when it comes out of the ground. It is easily worked, and can be flattened into sheets or drawn out into wires —that is, it is both malleable (măl'ē-ȧ-b'l) and ductile (dŭk'tĭl). It will take a brilliant polish and it will not rust; so it is largely used in household fixtures. In a damp climate it will get covered with the greenish coating we call verdigris (vûr'dĭ-grēs), but this may either be removed or left on for its beautiful color.

We use copper for a great many things. Because it does not rust we line our pipes



Courtesy Hamilton Wright

In the Chuquicamata copper mine in Chile's "Valley of the Moon" three churn drills are making holes for the explosives which will bring down the rich copper ore stored in the world's largest known deposit. Copper is Chile's principal product. To make this open-pit mine an entire mountain was cut away, leaving a hole 750 feet deep, a mile and a half long, and half a mile wide. Over 80 miles of railroad track run along its terraces.

with it and sometimes cover roofs with it. We make some of our pots and kettles of it. But above all we use it in electrical machinery. It is just possible that without copper electricity would not be at work for us to-day, and certainly it would be working far less well. For we need copper to make and handle electricity; most of the supply goes into motors, switches, wire, and other electrical equipment. With the metal beryllium (bĕ-rĭl'ĭ-ŭm) added, copper is hard enough to cut steel and makes good tools.

Copper is found in nearly all parts of the world, and is dug up at the rate of some three million tons a year—perhaps a third of it in the United States. Arizona, Utah, Montana, New Mexico, and Nevada lead in mining it. Canada, Chile, Rhodesia, Russia, and the Belgian Congo all export it.

Copper will mix, when melted, with many other metals. Mixed with tin it gives us bronze, and mixed with zinc it gives us brass. So we may as well talk next about tin and zinc.

Was Caesar Looking for Tin?

Tin is also one of the first metals that man learned to use, for it went into the bronze from which he long made so many of his tools. It is just possible that Julius Caesar

came over and conquered England mainly to get tin, for tin had been found there long before his day. And it is still mined there, though the great part of our supply now comes from the East Indies, the Malay States, and from Bolivia.

If Tin Cans Were Tin

Some people think tin is cheap and plentiful because they see so many tin cans around them. But a tin can that was really tin would be worth about a dollar; and even then it would not be much good, for tin is so soft that the can would collapse. The can is made of iron, which is much stronger. But iron would be so affected by the acids of the food in a can as to ruin the food for us. So the iron is dipped in a bath of melted tin, and comes out with a coating of the soft, white metal. The coating will not rust or be in any way affected by the acids of the food.

We do not often use pure tin. We see it most in the tin foil around candies and certain other things. For tin foil is pure tin, hammered into thin sheets. We know how soft it is, how easily it rolls and bends, and how bright it will keep.

Tin is widely used for mixing with other metals to make various alloys (ă-loi′)—the name we give to mixtures of metals. With copper it makes bronze, and with lead it makes solder (sŏd′ẽr); while with lead and antimony (ăn′tĭ-mō-nĭ) it forms pewter, out of which so many of our grandmothers' spoons and pitchers used to be made.

How We Get Our Zinc

For many a century zinc was used in combination with other metals by men who had no notion they were using it. For it is never found pure in nature, and only in fairly recent times has it been separated from the ores in which we mine it.

We can see it covering the iron pipes in many a kitchen and the jacket of the furnace in many a cellar. We see it on thousands of roofs—for a "tin" roof is really a roof of iron coated with zinc. Of course the coat of zinc keeps off rust. Coating iron with zinc is called "galvanizing." This is because it is put on by an electric current, which flows through an acid bath and evenly coats the iron we dip into the bath with little particles of zinc.

When we use some other metal for the coating we call the process electroplating. There are many metals that may be plated one upon another—usually a bright one is employed to cover up a dull one. Thus nickel or chromium (krō′mĭ-ŭm) is widely used to make a fine show at a slight cost.

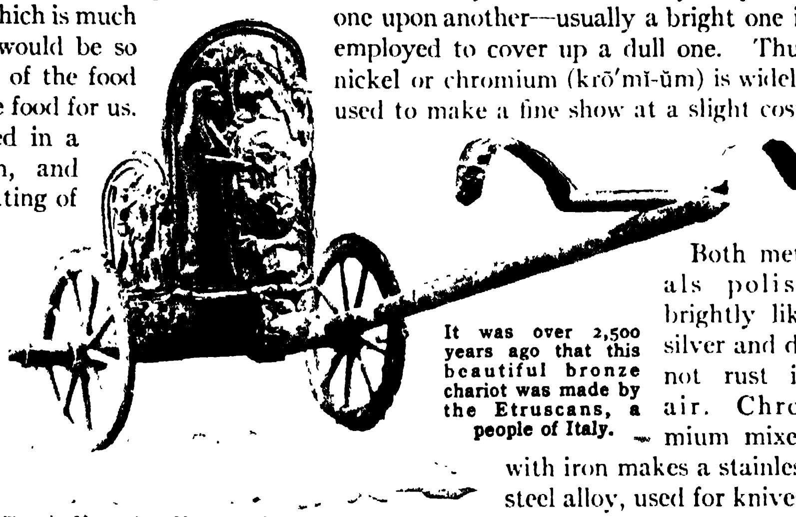


Photo by Metropolitan Museum of Art

It was over 2,500 years ago that this beautiful bronze chariot was made by the Etruscans, a people of Italy.

Both metals polish brightly like silver and do not rust in air. Chromium mixed with iron makes a stainless steel alloy, used for knives, tools, machinery, and automobiles. We use chromium compounds in tanning, in photography, and in making dyes and pigments. Chrome brick lines furnaces wherein other metals are melted. South Africa, Russia, and Asia Minor, and Cuba produce most of our chromite.

We also mix nickel with steel, to make the steel harder, and we use it in a number of alloys, like German silver—which is copper, nickel, and zinc. Most of our nickel comes from Canada, though we get a good deal also from New Caledonia, Cuba, and Russia.

A hundred years ago aluminum was so rare that a pound of it was worth about $545. Yet it is one of the commonest of metals, for it is found in ordinary clay all over the world, and is said to make up about one-thirteenth of the crust of the earth. The trouble used to be that people did not know how to separate this light metal which we have since

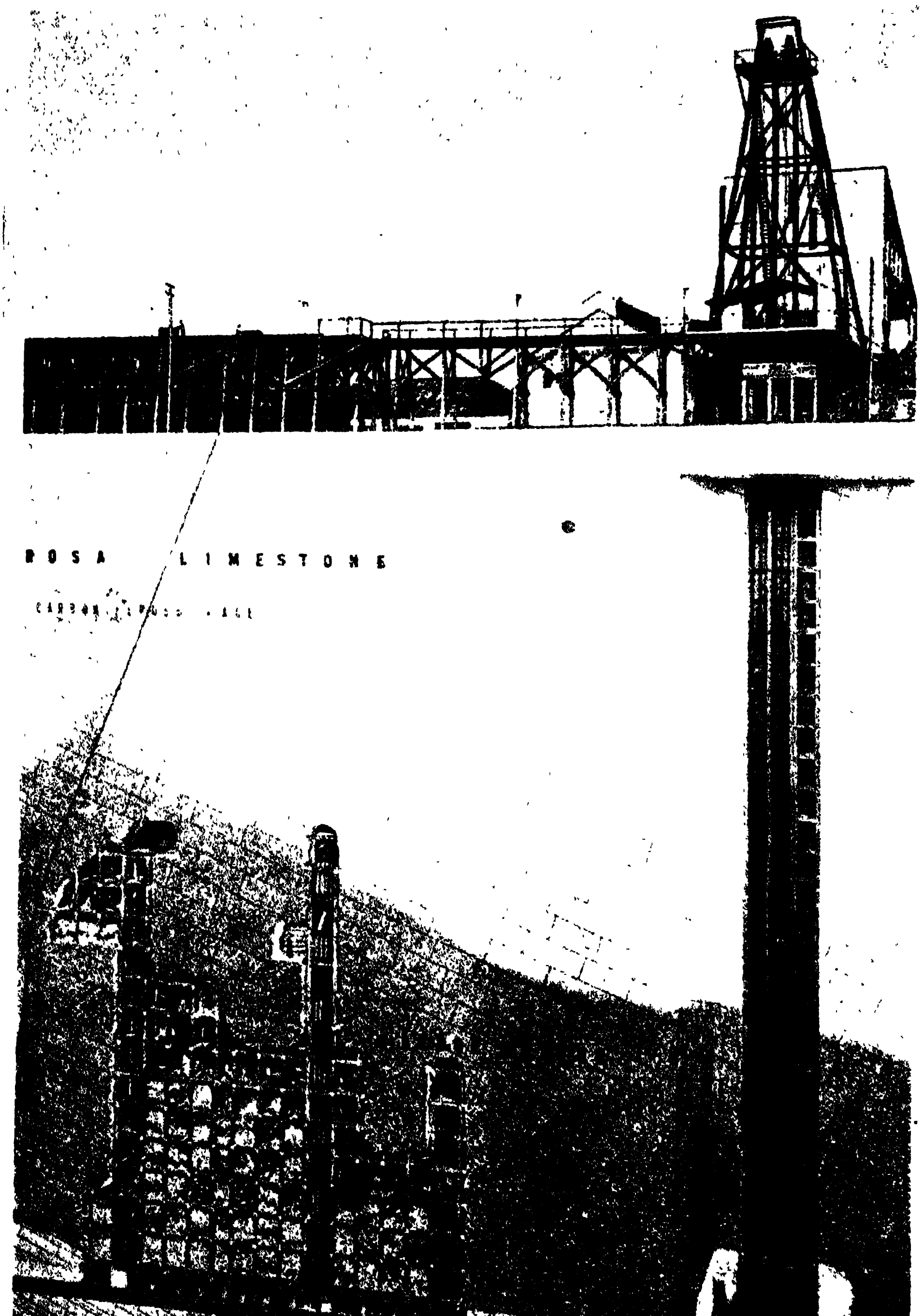


Photo by National Museum

This is a picture of a model of a copper mine. It is as if half the mine had been cut away down through the shaft, which you see at the right with two "cages," or small elevators, coming and going and with ladders in a third compartment. The wall of rock has supposedly been faced up with masonry, but where it is bare you may see all the timbered chambers which honeycomb the earth after the ore is taken out.

anadian National Film Board

These aluminum sheets have been rolled as thin as a wafer in one of Canada's great aluminum-working plants.

Now they are being heat treated. In the end they will be, for their weight, as hard as steel.

found so cheap and useful. Not until 1886 did we find an easy way to get it out of an ore called bauxite (bôk′sīt). Now its price is some fourteen cents a pound.

It has many virtues. It is light, does not rust or poison food, conducts heat and electricity, is easy to work, and is hard when alloyed with certain metals. So we use it for vessels for cooking and storing food, we make it into airplanes, automobiles, and even railway trains, we use it in the electrical, building, and construction industries, and make it into paint, furniture, and many small objects. It is our lightest common metal.

The United States, a large manufacturer of aluminum, gets most of its bauxite from Dutch and British Guiana and from Arkansas. But bauxite is found in many places—in Europe, Africa, and the East Indies.

Aluminum was a necessity in World War II, and so were the light metals magnesium and beryllium, which leaped into fame at that time. With other metals added to it, magnesium (măg-nē′zhĭ-ŭm) has the greatest strength of any common metal in proportion to its weight. So it is used in making tools, implements, and small parts of machines. Because in powdered form it burns readily when damp it had long been used for flares, in fireworks, and in tracer bullets. It is our third commonest metal, but is always found in certain ores such as dolomite (dŏl′ō-mīt) or magnesite (măg′nē-sīt)—or in sea water or brine. We find these ores in Nevada and California, and the brine we can pump from underground salt lakes in Michigan

Only about two centuries ago did we find out that platinum (plăt′ĭ-nŭm) was a separate metal. It is so rare that when it was first known it cost about $4 an ounce, and now costs many, many times as much. It is worth several times its weight in gold. Today it comes mostly from Canada, Russia, Colombia, South Africa, and Alaska.

The whitish metal is very heavy and rather soft, though it turns much harder when a little of the metal iridium (ĭ-rĭd′ĭ-ŭm) is added. It is highly malleable and ductile—an ounce of it will make a wire reaching from New York to New Orleans—and it never rusts. So it has countless uses in industry and science—especially for parts in machinery and precision instruments.

Because it resists the flow of electricity we use tungsten for the wire in light bulbs. It will get white hot instead of merely reddish yellow. Steel with tungsten added is so hard it cannot be cut when cold. So we use it for battleship armor. Bolivia, the United States—especially Idaho, Nevada, and California—Brazil, China, Argentina, and Peru are the chief producers of tungsten.

Reading Unit No. 6

WHAT IS THE MAGIC METAL?

Note: For basic information not found on this page, consult the general Index, Vol. 15.

For statistical and current facts, consult the Richards Year Book Index.

Interesting Facts Explained

The metal that is flying to pieces, 9–424
Changing one metal into another, 9–424
Madame Curie, 9–424-25
Radioactivity, 9–425
Uranium, ionium, and polonium, 9–425
The rays given off by radium, 9–426
Helium from radium, 9–426
Radium ores, 9–426

Things to Think About

How long does it take radium to change into lead?
How are radium rays somewhat like X rays?
Why does radium glow in the dark?
Why are large quantities of ore necessary to produce a tiny amount of radium?
Is radium too precious to be used to illuminate the dial of a clock?

Picture Hunt

What is the appearance of the light which radium gives off? 9–426
How did the ancient alchemists try to change one metal into another? 9–424

Related Material

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How is the structure of matter studied with X rays? 1–361
How are gamma rays used? 1–419, 10–495
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Practical Applications

How is radium used in medicine? 9–426
How is radium used to help us tell time in the dark?

Summary Statement

Radium is always breaking up into lead, giving off alpha rays, beta rays, gamma rays, and a gas, radon, which is used in medicine. Radium results from the breaking down of uranium.

Photo courtesy Australian News and Information Bureau

When the first atomic bomb was set off, the search for uranium suddenly became a matter of deadly importance. Here on the rugged Flinders Range in South Australia prospectors are finding large deposits of that amazing ore which yields radium and makes the atomic bomb possible. They are using an electronic device called a Geiger counter. When it gives off sharp clicks it tells them that a radioactive substance is near at hand.

WHAT IS *the* MAGIC METAL?

How Radium Can Fire Billions of Shots into the Air Every Second and Can Shine through Steel

OF ALL the metals ever mined, the most marvelous is radium. It is the nearest thing to magic in the world.

It has a light and heat all of its own. It frets and bursts with energy. And far more wonderful than that, it is always coming into being and then passing out of being. For strange as it may seem, another element is forever changing into radium, and then radium is forever changing into still a third element. Literally, radium is always flying to pieces and turning into something different.

Think a moment about what this means. There is nothing in the world that would surprise you quite so much as to find that a piece of iron in your hand was changing into a piece of lead—or a copper penny into a gold dollar. But that is just the kind of thing that radium does. It has to do that; it can never stay the same.

For many a century no one but the old alchemists, who were trying to make gold, ever believed that one metal could possibly change into another. As well expect a mouse to change into a cat! The idea that every metal must remain forever what it is was about the surest thing in science, or in all the world. And then all of a sudden, in 1898, we found this metal radium, which can never stay what it is, but is always turning into something else—and doing all sorts of strange things in the process! Then we had to throw away a lot of our surest ideas about science.

It was a woman who discovered radium. She was Madame Curie (kü'rē'), a Polish lady married to a professor in the University

of Paris, who aided her in her discovery. She and the other scientists who also began to study radium found that there was a whole series of elements that were always turning into one another. They are the elements that we call radioactive—meaning that they have the power of throwing off rays. In chemistry we call the process "disintegration" (dĭs-ĭn'tĕ-grā'shŭn)—which means that these elements break down and turn into other things.

The first of these elements is uranium (ū-rā'nĭ-ŭm), and the process starts in it. It breaks down through several stages into ionium (ī-ō'nĭ-ŭm), which in turn breaks down into radium—the most marvelous element in all the series. Then radium breaks down into polonium (pô-lō'nĭ-ŭm), and polonium finally breaks down into common, ordinary lead. Then the process stops, for lead stays what it is. So we start with uranium, come down through the magic radium, and end in everyday lead. And this process of changing has been going on ever since the world began.

Marie Sklodowska Curie (1867-1934), most distinguished of women scientists. By her work in the discovery of radium she helped to revolutionize scientific theory.

Now how does radium do this thing? Well, we have said that it is always in a fury of energy. It is forever hurling off little particles of itself into the space around it. It is only lately that scientists have learned about what takes place when this occurs. They now know that the particles hurled off—which are of the tiniest—are very, very small electrical charges. It would take billions upon billions of them to be big enough to see. But the slowest of them fly off from the radium at the terrific speed of ten thousand miles a second—nearly forty thousand times as fast as the earth spins. And they fly off in enormous numbers. In a single second a single ounce of radium will shoot off . . . Well, how many atoms do you guess? Just about a thousand billions, or a trillion. No wonder we said radium was furious with energy. We have told more about it in our story of atomic energy.

Since each of the tiny particles shot off is merely an electrical charge, it is no longer radium. So when all the particles have been shot off, there will be no radium left. How long will that take?

A long time, if you watch it by the clock, but only a short time if you time it in certain other ways. Even though an ounce of radium would shoot off a trillion atoms every second, the atoms are so tiny that half of the ounce would still be left after eighteen hundred years. So with all its fury, you must not suppose that you could see the radium changing. But if you time it by some big rock or mountain, the radium will waste away very fast indeed. The mountain will last for millions of years, and while it is still in infancy the radium will be gone. Or you can time it by uranium. Uranium has the same habit of flying to pieces, but it needs a billion years for a small bit of it to waste away.

In all this commotion radium gives off a great deal of heat and light. An ounce of it would boil away four ounces of water every day for eighteen hundred years, and

then be only half gone. It would light a room the same way. In that period it would produce more than a million times as much energy as the same amount of burning coal.

But no one could live in the heat and light of radium. The rays from radium are very dangerous. They will go right through our flesh and clothing and give us dreadful sores like burns. They will kill us if we are exposed to too many of them—and it does not have to be very many. In order to keep radium harmless we must shut it up in lead, for its rays do not go through thick lead.

There are three kinds of rays that fly off from radium, and they are named after the first three letters of the Greek alphabet—alpha, beta (bā'tȧ), and gamma rays. The particles in the alpha rays turn into the light gas, helium (hē'lĭ-ŭm). They are not very penetrating, and can be stopped by a sheet of paper. The beta rays travel far faster—sometimes nearly as fast as light—and will go through a thin sheet of aluminum. Both of these are charged with electricity. The gamma rays are much the most penetrating of all; they will go through six or seven inches of steel. In this way they are like X-rays.

In addition, radium gives off a gas which is called radon (rā'dŏn), and which has even more marvelous powers than radium itself. In fact, it is sixteen thousand times more active than radium. It is this radon that is mostly used in our hospitals.

If radium does all these things, why do we see so little of it? Most of us never see any at all. That is because there is so very little of it in the world, and even what there is is very hard to secure. In the first thirty years only half a pound of it was mined, and that half pound sold for at least two million dollars an ounce.

In Canada, Czechoslovakia, the Belgian Congo, South Africa, and a few other places there are deposits of pitchblende and other minerals out of which by hard work we can get a tiny grain of radium. For one gram of radium—a twenty-eighth of an ounce—we may have to grind and pulverize, and boil and wash and treat some two hundred tons of the tough ore. A whole trainload of ore for half a pinch of radium!

And what is the magic metal good for? Surely the main thing has been to show us so much about the wonder of this world—only part of which has been told here, only part of which has yet been found out by the scientists. But radium is also used in medicine, for the relief of certain tumors and cancers, and for other purposes. Most of us know radium best from the clocks and watches that will tell time in the dark. The hands and figures glow with a bluish-white gleam in the night, which comes from radium on them. But if radium is so costly, how can we afford it for our clocks?

Because a very little of it mixed with zinc sulphide (sŭl'fīd) goes a long way. There is only about twenty cents worth of radium on a watch. Now if an ounce of radium costs about two million dollars, how much of it goes on a watch?

That's right—about one ten-millionth of an ounce! And yet it makes the hands and dial glow brightly in the dark.

Of its own violent energy radium is able to glow like this when it is exposed in a dark room. That is why it can light up the dial and hands of a watch or clock.

When radium is used in hospitals for the treatment of disease, the doctors and nurses have to take elaborate precautions against the burns it may give them.

Reading Unit No. 7

WHICH ARE THE FOUR PRECIOUS STONES

Note: For basic information not found on this page, consult the general Index, Vol. 15.

For statistical and current facts, consult the Richards Year Book Index.

Interesting Facts Explained

What is a diamond made of? 9–429
Synthetic diamonds, 9–429
What is the source of diamonds? 9–429-30
Which are the world-famous diamonds? 9–430-31
How heavy is a carat? 9–430
What are rubies? 9–430
Synthetic rubies, 9–432
Sapphires, opals, and emeralds, 9–432-33

Things to Think About

Why does a diamond sparkle?
How is a diamond cut?
Why is a synthetic ruby a real ruby?
How does an opal get its rainbow tints?
Do people want gems because the stones are beautiful or because they are expensive?

Related Material

Can diamonds be formed outside the earth? 1–166-67
How were diamonds discovered in South Africa? 5–485
How are diamonds used to cut hard materials? 9–379
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How were gems used in constructing the Taj Mahal? 11–450, 5–366, 375

Practical Applications

How are gems used to make watches keep time? 9–433
How are diamonds used for cutting and drilling hard substances? 9–431

Leisure-time Activities

PROJECT NO. 1: Make a green ruby, 9–432-33.

PROJECT NO. 2: Make a model of the Taj Mahal, 9–432.

Summary Statement

Diamonds, rubies, sapphires, and emeralds are "precious stones" because they are rare and therefore bring a high price.

From earliest times down to our own day, among painted savages and exquisite ladies, jewels have been admired and treasured and fought over. A precious stone may be cut and recut, but it is always the same stone—and what strange tales many of them could tell if only they could speak! We know a little of the history of certain famous gems: how this ruby was stolen from the forehead of a Hindu god, how that diamond was sold to raise funds for a war. But even the most famous stones hold secret most of the loves and hates and adventures they have known, and of the opal or the sapphire in our own ring we know nothing at all. Many of the jewels worn by the lady in this picture, who is being so courteously served by an ancient Roman jeweler, may very well be still afloat in the world, but no one knows where.

WHICH ARE *the* FOUR PRECIOUS STONES?

And Which the Semiprecious? And What Is It That Makes a Pebble Cost Several Million Dollars?

LONG ages ago, when Mother Nature was still stirring things up a good deal, she hid here and there in the earth millions of tiny sparkling crystals—green and blue and red and white. They are our gems, or "precious stones." They lay hidden for many thousands of years, until busy little streams pried them out of the rocks and carried them away—only to drop them carelessly whenever they got too heavy for the current to bear. Over long years they were tossed about and about, rolled and scraped and ground by the water and rocks, until one day a man came by and saw the flash of fire in one of them. He picked it up and took it home to give to his wife or his god, and ever since then men have struggled and fought and died to find those tiny flashing bits, and have paid millions of dollars to own a handful of them.

It is only because they are so hard to find that they cost so much. Some of them can be turned out in a factory for only a few dollars. But if it has been made by Mother Nature, a single little piece of stone may cost a fortune.

There are a great many kinds of gems, of beautiful fire and color, and most of them have been known as far back as history goes; but there are only four that we call "precious stones." Those are the diamond, the ruby, the emerald, and the sapphire. All others are "semiprecious," no matter how beautiful they may be.

The queen of all jewels has always been the diamond, though as a matter of fact rubies or emeralds may sometimes bring a higher price. The Roman Pliny, who lived in the first century after Christ, says that the diamond is "the most valuable of gems, known only to kings." A great many people can own diamonds to-day, but the price of the finest ones is still appalling. A single stone may well be worth two or three million dollars.

There is something cold and regal about a diamond's clear white brilliance. It seems to flash with a light of its own. And there is a reason for this. As you know, when a ray of light passes from the air to some other medium—like glass or water—the ray is bent at the place where it enters the second substance. Now a diamond bends light a great deal—much more than glass, for instance. So a good many of the rays entering a diamond are bent so far that they are tossed back and forth inside the stone before they finally get out. It is this "imprisoned" light that makes the diamond seem to flash with its own fire.

Most of the world's diamonds now come from South Africa, where the picture above was taken. When the dirt that contains them has been brought to the surface, it has to lie "weathering" for six months before the diamonds are washed out. To the right are gem cutters in Ceylon. Most of their work is now done in factories.

Photos by South African Rys and American Museum of Natural History

What Gives a Diamond Its Fire?

A diamond owes its brilliant rainbow colors to the fact that when the stone separates a ray of white sunlight into the colored rays of which the white light is made, the diamond can spread the colors into a very wide and vivid rainbow. That is the reason why a diamond sparkles with brighter colors than any other gem. Then, too, if you rub it, or let it lie in the sun for a time, you will find that it glows in the dark.

Before they are made into jewels of sunlit beauty, diamonds lie buried in the earth. Men have never made out exactly how Mother Nature made them, but we know that they are pure carbon—just the same substance that goes to make a lump of coal, or the "lead" we write with. Under terrible heat they will take fire. But it took great pressure, as well as terrific heat, to change their dull stuff into a thing of such splendor.

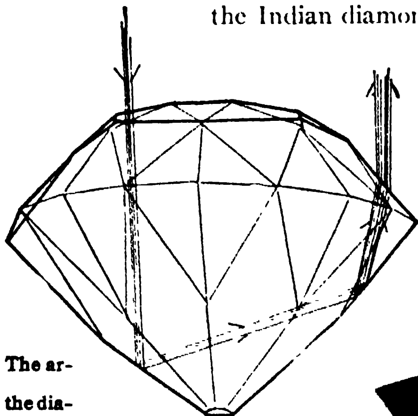
Diamonds have even been made in a laboratory, but the stones were so small that they could not be seen without a microscope, and the process was so expensive that it does not pay. They are imitated in many ways, and the best imitations are made from a very heavy glass. These are called "paste" diamonds.

But though man cannot make very good diamonds, he can do a great deal to make the stones more beautiful. For as they come from Nature's hand they are nothing but rough, misshapen bits of crystal that have a rather greasy look. Even then they sometimes flash with fire, and betray themselves to passers-by, who search for others in the bed of the stream or in the clay bank where the stones lie, and so open up a diamond mine. But it is not till the precious pebbles are cut into the shapes we know and are highly polished that the flames in them are lighted.

Where the First Diamonds Came From

The first diamonds in the world came from India. It was from there that the Romans got them and some of those early gems were very famous. People still speculate as to

what ever became of the "Great Mogul," a stone weighing, it is said, 787 carats in the rough and found at Goldonda, a center of the Indian diamond trade.



The ar- the dia- gram above show how light comes into a diamond, is bent and bent again by the tilted planes of the under surfaces, and comes out finally on top, making the gem sparkle as with an inner light.

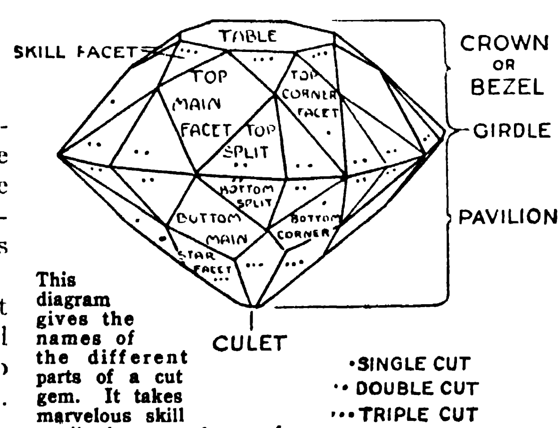
Some think it was cut up to make two stones that are famous to-day. One is the "Orloff," a magnificent gem that is said to have been stolen by a French soldier from the eye of an idol in India. It finally became one of the Russian crown jewels when it was bought for $4,500,000 and presented to Catherine II of Russia, in the eighteenth century. The other stone is the "Koh-i-noor," a famous diamond that has belonged to the English crown ever since it was presented to Queen Victoria in 1850.

The Indian mines have been worked out for a long time. But about two hundred years ago the king of Portugal began to reap a harvest out of the diamond mines in Brazil. They, too, gave up their treasures. Nowadays it is South Africa that is being robbed of her gems to deck out the world. The famous "blue ground," a bed of volcanic stone found around the town of Kimberley and in other places, is now producing millions of dollars' worth of stones a year. Nearly all of the world's output is in the hands of the De Beers Company, a great diamond monopoly created by Cecil Rhodes.

It is the perfectly white diamond that is most highly prized, though stones with a bluish cast are also very valuable. A yellowish tint robs a diamond of part of its worth, and so does any flaw or cloudiness. When a stone is without flaw or the slightest tinge of color, it is said to be of the "first water." One slightly less clear is of the "second water"; one still less clear of the "third water." Gray and brown diamonds are found, and once in a while a red, green, or black one. The most valuable diamond in the world is probably the "Regent," owned by the French government and estimated in 1912 as being worth $2,400,000. It is a good deal smaller than the "Orloff" or the "Koh-i-noor," but it is remarkable because it is so flawless. The

The first thing that happens to a diamond after it has been mined is a visit to the sorter, as shown in the oval below. This expert's eye is so nicely trained that he can see flaws or a stain of color in stones that would look perfect to most of us. Only about 25% of the stones are absolutely clear. Perhaps half of them are so deeply stained that they cannot be used for ornaments at all.

Photos by Government Information Office Union of South Africa and Visual Education Service



This diagram gives the names of the different parts of a cut gem. It takes marvelous skill to tilt the many facets of a diamond at just the right angle.

largest stone ever found was the Cullinan diamond. It was dug up in an African mine in 1905, and weighed one and a third pounds in the rough.

When you have a substance so valuable as a precious stone, you cannot rely on ordinary grocer's scales to weigh it. Many diamonds are no bigger than pinheads. And since the price of a precious stone depends quite largely on its size, the gem must be weighed to the tiniest particle. So we have a special kind of scale for jewels, and it weighs everything in "carats" instead of in ounces. To pick up a jewel weighing a quarter of a carat, we must use a pair of tweezers and even then the precious mite is hard to get hold of, for it takes 151½ carats to make only an ounce troy—and there are twelve troy ounces in a pound. The great Cullinan diamond weighed 3,024 carats.

Photo by Australian Govt

Most of our "blue rubies," or sapphires, come from Southern Asia, Australia, and the islands between. Here are experts in Australia sorting the glittering gems.

The Hardest Thing in the World

While it is true that diamonds are valuable because they are used as gems, it is not beauty alone that makes a diamond remarkable. A diamond is remarkable in many ways. For one thing, it is the hardest substance in the world. It will cut anything! Men knew this long, long ago, when the diamond was given its Greek name, "addamas," which meant "the invincible." Our words "diamond" and "adamant" both come from that Greek word. Because they are so hard, diamonds are used for cutting and drilling glass and porcelain, for fine engraving, for drilling in dentistry, for bearings in watches, and for drilling through solid rock. When they are used for rock drilling, the diamonds are set around the outside of steel tubes or disks or bands, which are made to turn around rapidly.

But if a diamond is so hard that it will cut anything, what can be used to cut a diamond itself? There is only one thing that will cut a diamond—and that is another diamond! All of a stone's little sparkling sides are cut with a wheel, the surface of which is covered with diamond dust. And because a diamond is so very hard, it can be made to take the highest polish of any substance in the world.

But diamonds are not the only million-dollar gems. A large ruby, red as pigeon's blood and gleaming without a flaw, is very precious. A really big stone would be almost priceless. Rubies are not, as a rule, so large as diamonds, so a good-sized ruby is considerably more valuable than a diamond the same size; it may cost ten times as much. And a truly perfect ruby is hardly to be found. Nature is a little careless in making them. She melts them, in her underground workshop, out of a form of aluminum, and hides them in the rocks. But little streams find them out and carry them along till they finally drop them in the gravelly beds.

Nearly all mountains contain some ruby sands, though not often in a form to be valuable. We must journey to Mandalay, in Burma, to see the mining of perfect rubies. The little country has for a long, long time given her gems to the princes and rajahs of India. Indian rulers are always resplendent with jewels, but the ruby is their supreme favorite, and has played a large part in oriental war and adventure.

A Single Gem That Is Worth a City

Even to-day those rajahs boast of rubies that are valued above the worth of cities. Sometimes they wear the jewels in their royal robes. Often they give them to their gods and put them in temples, where the idols are supposed to protect them against thieves. It is an Indian prince who owns the largest flawless ruby in the world. Though it is big for a ruby, it weighs only fifty carats.

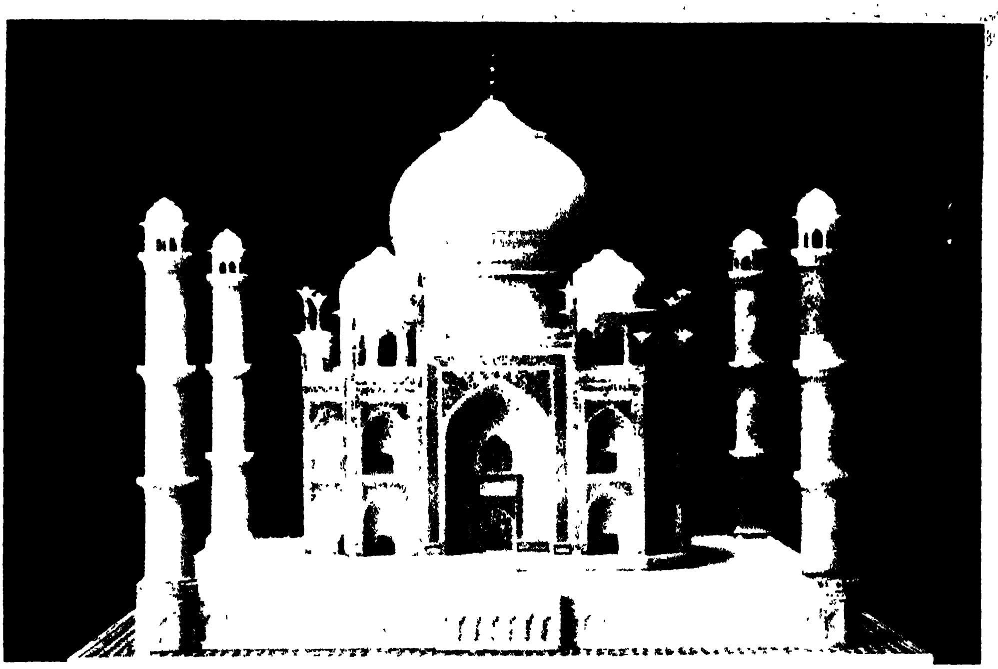


Photo by Field Museum

The Taj Mahal, often said to be the most beautiful building in all the world, is itself like an exquisite jewel in the stainless whiteness of its marble. And within, all the walls are encrusted with real jewels turquoise, onyx, amethyst, jasper, sapphire—inlaid in the finest mosaics in all the Orient. Therefore it has been said of the Taj Mahal that it was planned by Titans, or giants, and finished by jewelers. This matchless gem among buildings, which stands on a sheer cliff over the river at Agra, India, was built in the seventeenth century by the Mogul emperor, Shah Jehan. He had lost his wife, Mumtaz Mahal, called Taj-Bibi, one of the loveliest of women; and he swore that she should have the most magnificently beautiful tomb in the world. Surely he kept his vow! Of course it took vast treasure to build such a tomb, but Shah Jehan was so rich that he thought nothing of that. It was he also who completed the famous Peacock Throne, the most gorgeous thing of which even the East could boast. It was formed like a bed, with twelve jeweled columns holding up a canopy studded with diamonds and fringed with pearls. An enormous diamond—perhaps the lost "Great Mogul"—flamed in the center of the canopy, set amid rubies and emeralds. The peacock itself, which perched on top, was of gold inlaid with precious stones; in its breast smouldered a huge ruby from which dangled a great pear-shaped pearl. In 1739 all this was carried off to Persia.

Rubies can be manufactured very successfully, and twenty million carats of them are put on the market every year. We call them synthetic (sĭn-thĕt′ĭk) rubies. They cost only a few dollars and are just as truly rubies as the ones that Nature makes. Only an expert can tell them apart. The demand for them is growing every year.

How Gems Get Their Color

You will probably find it hard to believe that the blood-red ruby and the bright blue sapphire are really the same stone. But it is true. Both of them are "corundum," a substance Nature makes out of a form of aluminum. It ranks next to the diamond for hardness. The only difference between a ruby and a sapphire is in the coloring matter that has gone into them. Corundum may be white, too, and then it is called "white sapphire"; or yellow, when it is called "oriental topaz"; or green, when it is called "oriental emerald"; or violet, when it is called "oriental amethyst"; or greenish blue, when it is called "oriental aquamarine." And the interesting part of it all is that those "oriental" topazes and emeralds and amethysts and aquamarines are more valuable than the genuine stones, for they are harder and more brilliant. "White sapphires" are sometimes ground to make lenses for microscopes.

How to Make a Green Ruby

When the various stones made of corundum are heated, they will usually change

color. A ruby turns green, though when it cools it is red again. But heating will make a yellow sapphire—or oriental topaz—into a pink topaz, and it will take the color out of a blue sapphire entirely.

Sapphires are of course made by Mother Nature in the same way as their brothers the rubies, and are mined in the same way. But while the red members of the family are small and very costly, the sapphires are large and are cheaper than diamonds. Sometimes the same mine will yield rubies and sapphires together.

The finest sapphires now come from Siam and from Ceylon, which has been famous for them for a very long time. Large ones have been found in the United States too—in certain gravel banks in North Carolina and in sand bars in the Missouri River in Montana.

The Jewels in Our Watches

In color sapphires range from deep indigo to pale blue, and a given stone may even be blue at one end and yellow at the other. But the most valued shade is a deep, rich blue. Very pale or whitish stones are not worth much, but because they are so hard they are useful in making the bearings that the little wheels in watches turn on.

Sapphires are greatly admired, and the large brilliant ones are very valuable. The largest cut sapphire weighs 950 carats. Of course they can be manufactured, just as rubies are; 12,000,000 carats of synthetic sapphires are turned out every year.

The exquisite green of the emerald, as deep and clear as the waves of the sea, has enchanted men for many centuries. The Egyptians used to mine it by the Red Sea, and Nero, the Roman emperor, watched the games in the circus through an eyeglass made from an enormous emerald.

But it was not its color alone that charmed people. They thought it had magical powers to keep away disease. When the Spaniards went to Peru they found the Indians working charms with emeralds, and magic has followed the jewel down the ages.

Of course all gems have been given strange powers in men's imaginations. Amethysts were supposed to prevent drunkenness, diamonds to prevent insanity and insure a happy marriage, and turquoise to bring good luck. In fact there are still people superstitious enough to believe that it is lucky to wear one's birthstone—though no two lists agree as to what that birthstone is!

To-day the emerald is worn for its beauty alone, and stones of a certain color will bring a thousand dollars a carat. The finest come from Colombia, but they are mined in Siberia, too. The Czar of Russia used to own some famous emeralds.

But emeralds are not useful, as diamonds and sapphires are, for they are not so hard. They belong to a variety of mineral known as beryl (bĕr'ĭl). It contains aluminum and beryllium, and gives us certain of our semi-precious stones, such as the beautiful bluish-green aquamarine, the rare pink beryl of California, and various other blue, green, yellow, brown, and white stones.

One other jewel is often called a precious stone, though it really is too soft to be classed as such. That is the glowing opal. It has no single color, but holds a smoldering fire of many colors. In some moods it is white and cloudy, but give it a chance, and it will burst into flame.

An opal is not a single crystal, as a precious stone is. It once was a sort of jelly in hot, volcanic rock—and when it cooled it turned to stone. But as it cooled there formed in it thin layers of materials of a different kind, and it is these "bubbles" that give the opal its rainbow tints—like the tints we get from a soap bubble. The mineral called silica (sĭl'ĭ-kȧ) goes into the making of an opal, and the stone contains, besides, very tiny particles of liquid carbon dioxide—which is nothing more nor less than soda-water gas!

The finest opals have always been mined in Hungary, but good ones come from Mexico, too, and from Colorado. Australia mines black opals. The largest opal in the world was among the Hungarian crown jewels. It is five inches across.

Many kinds of quartz and jade and amber are beautiful enough for a queen to wear. If they were as rare as precious stones, they would probably be as expensive.

Reading Unit No. 8

SECRETS IN A LUMP OF COAL

Note: For basic information not found on this page, consult the general Index, Vol. 15.

For statistical and current facts, consult the Richards Year Book Index.

Interesting Facts Explained

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Black diamonds, 9–436
The origin of coal, 9–437
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Things to Think About

When we use coal, are we burning trees?
How do chemists get products from coal?
How is coal graded?
How is every part of a piece of coal used?
What would be the result of the sudden discovery of a cheap substitute for coal?

Picture Hunt

How did plants turn into coal? 9–336
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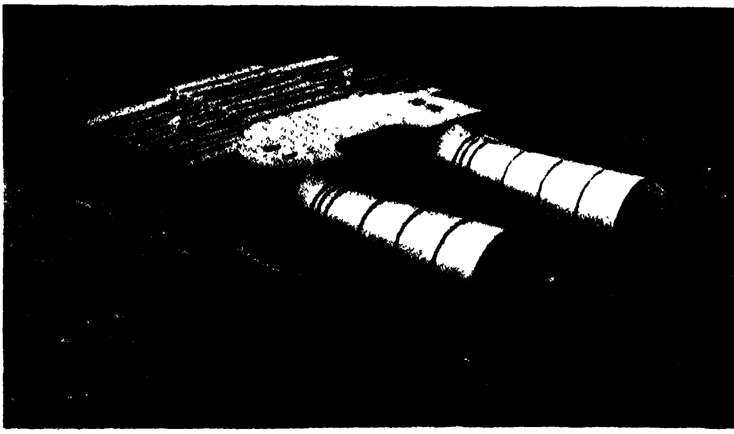
Practical Applications

How does coal provide us with many useful products? 9–443-47
How does coal help us in our daily lives? 9–444

Summary Statement

Coal, formed from trees and other plants that lived millions of years ago, is useful to man in many different ways.



Giant blowers like these two are used in modern mines to force clean air into the underground galleries where men are working. This is one of the mechanical means by which the work of the miner is made safer and more efficient.

Photo courtesy Bituminous Coal Institute

SECRETS *in a* LUMP *of* COAL

Here Is the Long Story of the Black Diamonds That Were Stored Up Ages Ago for Us to Burn To-day

HAVE you ever stopped to think that this good old earth on which we live, on which we run about and are so busy, and to which our bodies will return when we do not need them any more, is really a vast storehouse of treasure from which we get all the wealth there is in the world? Do we need food? In one way or another we must get it from the earth. Do we need houses and clothes? Just go to Mother Earth and in one form or another she will furnish them all. Do we need useful ores? There they are, tucked away in her ample folds. Do we need heat and power? Leave it to Mother Earth and she will give you the means to have them in plenty. She is like a fairy godmother who keeps hidden away anything we may want; only we must find out for ourselves how to use her gifts, and must dig and scrape and pry about in order to find them.

Now for long centuries men knew how to make use only of what they found right at hand. They killed the animals and garnered the fruits and grains and—after a long, long time—learned how to make a fire of trees that grew in the forest. During all that time the earth was full of amazing treasures that people knew nothing about. But after another long time came the growth of science—and with it our modern age. Suddenly men woke up to all the riches that lay around them, and they began to ransack every cranny of the earth to see what she would yield.

One of the things that they wanted most was fuel. They had to have it to make their iron and steel, to drive the wheels of their factories and locomotives, to heat their homes and other buildings. There was wood, of course, but the forests could never supply all the heat the world suddenly found it had to have. And besides, wood could not give an intense enough heat, anyway.

It was here that Mother Earth stepped in with precisely the right article. Long ages ago, when she was just a young thing, she had carefully laid in a store of concentrated sunlight. Deep in the earth she had buried it, and had kept it there for thousands and thousands of years. Men had known for some time that she had it stored away; the Greeks had known it, and so had the Saxons in England. Indeed, it had been used long before that, for near the surface in a vein of coal in England there once were found a number of stone hammers and picks that must have belonged to men way back in the Stone Age of human history. Those hammers and picks had been used to get

out the coal, which cooked the meat and warmed the caves and huts of those Britons of thousands and thousands of years ago.

But none of the early men had any particular need for the mysterious shiny black rock that would burn with such great heat. So it was not until the middle of the eighteenth century that the mining of coal was really begun in earnest. In the United States it was mined near Richmond, Virginia, as early as 1750; but on account of its weight it could not be hauled for long distances and so at first was used only in regions close to the mines. During the Revolutionary War the colonists used coal in making cannon balls.

Canals Made Coal Cheaper

Gradually canals were opened down which coal could be shipped more cheaply. Then, with the coming of the railroad, it could be sent to every corner of the land. Hungry factories sprang up, to eat it in ever-increasing quantities until today for every person in the United States more than three tons of coal are mined every year—or nearly five hundred million tons in all.

And what is this strange stuff that makes the wheels of all the world go round? It is made largely of carbon, the same material that makes a diamond. Indeed coal is often called "black diamonds." But the comparison is really unfair to the coal. For all the diamonds in all the mines that this great earth contains are not worth more than the tiniest fraction of what our coal is worth to man. It is literally true that in the coal is stored away the heat that the sun poured down on the earth millions of years ago.

Our world was young then, and very warm, so warm that few of the living things that we know now could have endured the heat. But the dense, steamy jungles were crowded with rank vegetation. There were giant ferns that grew as large as trees, forty or fifty feet high, and great plants, of the kind we know as horsetails, that were as big around as the mast of a ship. Thick, spongy mosses covered those strange plants and carpeted the jungle.

How Trees Were Turned into Coal

And as the great plants died, they fell into the swamps where they grew, and sinking deeper and deeper formed gigantic bogs full of decaying stems and leaves. Then as

Drawing by Robert Reid Macguire

These pictures show how, during millions of years, vast layers of vegetable matter were turned into coal. First there was a low-lying marshy land dense with vegetation and flooded with shallow water (a). It was a nightmare land! Horrible monsters, sometimes fifteen feet long, crawled through the mud and slime. Swarms of tiny animals throve in the warm waters—so many that great thicknesses of limestone were made entirely of their limy shells. The neighboring trees and ferns—enormously tall, with fibrous shells and soft pulpy centers—helped to fill the pool by dropping in twigs, bark, and seed pods. Little water plants and mosses took root along the sides of the pools, and floating plants spread over the surface of the water (b). Mud and decay and other sediment gathered at the bottom (c), and finally the water plants on the sides and surface spread until the whole area was filled in (d), and became a quaking bog. Nature later made the moldy mass into a substance so useful to man that nations have fought to get control of it.

Photo courtesy United States Steel Corporation

These miners are testing the air at the coal face to be sure no poisonous methane gas is present. If the air is bad their lamp will flare up and burn blue. Where you can see "OK" chalked on the coal the air is safe.

the earth's crust cooled and wrinkled, earthquakes shook it and cracked it open, and the bogs on its surface sank down, many of them, and were gradually covered over with mud and stones that sea water heaped upon them. Then by and by, other gigantic plants sprang up on the new soil, and they in turn were buried. Sometimes this process was repeated over and over again.

Now many scientists believe that on the great plants that sank down into the slime were billions of tiny plantlike organisms that we call bacteria (băk-tē'rĭ-ȧ). They are too small to be seen but they are very powerful, for when they start growing in a substance they cause all sorts of changes in it. For instance they make meat rot and milk sour. After the giant plants had fallen into the bog, the bacteria set to work and made the plants decay. This chemical change set free many gases, like oxygen and hydrogen (hī'drô-jĕn), which escaped into the air. But what we call carbon was left, and in the carbon the sun's heat had been stored. Only the touch of flame was needed to set it free again.

It was a long time before the change was fully made. The decaying matter, under the weight of the deposits above it, first turned to what we know as peat. We have plenty of that today, though the plants that make it are no longer the giant ferns and horsetails of long ago. As we find it now, it is a kind of wet, rotting turf, often full of moss. It is found in the swamps of all the northern countries of the globe. Russia has the most of it, and Canada and Finland come next, but it is not used much in lands that have plenty of other fuel. Ireland probably uses the most, for out of the peat bogs that cover about a seventh of her surface, she cuts as much as six million tons of it a year.

Peat Is always Found Wet

Peat may be a pale yellow substance that looks a good deal like compressed hay, or it may be dark brown and claylike. Of course it is always wet from the bog that it has been formed in, and must be dried before it is good for fuel. Then it burns slowly and gives off thick black smoke.

The Dismal Swamp in Virginia is a typical peat bog. Sometimes such a swamp will have peat thirty feet deep, and the constant growth and decay of plants at the top will add to it every year. When the peat is

gathered, it is cut out in the shape of bricks and stacked up to dry, though lately in Sweden and Germany machines have been used for gathering, or "winning," it.

But the peat that formed in those great swamps millions of years ago has disappeared long since. As it sank down and down under the weight that kept gathering above it, as it decayed and had the moisture pressed out of it, and as the folding of the earth's crust wrenched it and squeezed it and crushed it, the soft peat was turned in the course of ages into a brownish substance we call lignite (lĭg′nīt), or brown coal. It is not coal yet; it is still too soft, and there is still too much other matter mixed with the carbon. But it has gone a step beyond peat in becoming coal. True lignite often shows the structure of the plants that went to form it, and looks like decaying wood, but much brown coal has gone beyond that stage on its journey towards the coal which we all know so well.

Germany has mined more brown coal, or lignite, than any other country, but much the largest deposits of it are in America. In the United States North Dakota produces by far the most, but Texas, Montana, and South Dakota mine it also.

Why There Are Many Kinds of Coal

Gradually the weight of sand and gravel on top forced the lignite down and down into the earth, where the temperature is much higher than it is near the surface. And all sorts of twistings and convulsions and foldings took place as the earth's crust shrank. Under the tremendous heat and pressure great changes were wrought in the lignite, and at last it was turned to coal. So the sunshine which had gone to make those giant jungle plants of long ago was now imprisoned in the form of carbon. And as if to prove it past a doubt, lumps of coal are mined from time to time that still bear the imprint of those ancient ferns and horsetails.

Of course the coal in the world was not all formed at the same time. So there are a good many kinds. The oldest is hard and shiny and burns with little smoke and flame. This is called hard coal, or anthracite (ăn′thrȧ-sīt). It is the best coal for heat, since it contains 90 percent or more of carbon. In fact it is so hard that for a long time no one knew how to set it on fire, though people knew it would burn. Finally some men in an iron foundry, who had been working all one day and night trying to get hard coal to burn, threw a shovelful of it into a wood fire and went off to breakfast. When they came back the coal was burning with such heat that it had almost melted the furnace. Although the largest deposits of it are in Asia, most of the anthracite that is mined comes from the United States, where there are great beds of it in Pennsylvania.

Most of the coal that is mined is soft, or "bituminous" (bĭ-tū′mĭ-nŭs). Its dull, crumbly chunks burn with a thick black smoke that is allowed to blanket some of our cities with smut. Coke ovens can now capture the odorous smoke and make it yield up the chemical riches it contains. Soft coal is found in a good many parts of the world, in Russia, France, Spain, Belgium, Sweden, China, India, and Burma. Canada, too, has large areas of excellent coal, and there are beds of it in South America, South Africa, and Australia. In the United States Pennsylvania produces the most, but it is mined in West Virginia, Illinois, Kentucky, Ohio, Indiana, Alabama, Virginia, Wyoming, Colorado, Tennessee, Utah, Montana, and other states. The United States produces a third of the world's total output of coal, and Great Britain an eighth. Germany was the third greatest producer. In 1935 she regained possession of the rich deposits in the Saar Basin, when the Saar population voted to be returned to her. But she lost the Saar in World War II.

Coal for the Future

Of the world's reserves of unmined coal, the United States has about 40 percent. The best is in the East. The quality falls off as one goes west until the Rocky Mountains are reached, but there some anthracite is found, together with other varieties. Much of this mountain territory has not yet been explored for its coal, but the reserves are known to be very large. Alaska too has vast deposits. In fact the only part of the country that is really short of coal is the region

The galleries of a coal mine that has been operating for a long time will reach far into the earth. The miners would waste time if they were to walk to work. So this little train transports them to and from the depths of the mine.

This electric drill is mounted on a post which is anchored to the roof and floor to hold it steady. The holes it cuts for explosives go deep into the coal seam, as you can guess from the length of the bit lying on the floor. Notice the miners' lamps, powered by the batteries they wear on their belts.

There is not much in these concrete tunnel openings to suggest the humming activity going on far below the surface. The powerful locomotive just disappearing into the tunnel mouth has replaced the horses and donkeys of earlier days.

Photos courtesy United States Bureau of Mines

Photo courtesy Bituminous Coal Institute

As a safety measure limestone dust, which will neither burn nor explode, is blown over the face of the coal. It mixes with the coal dust, which its weight keeps from moving about and spreading fires and explosions.

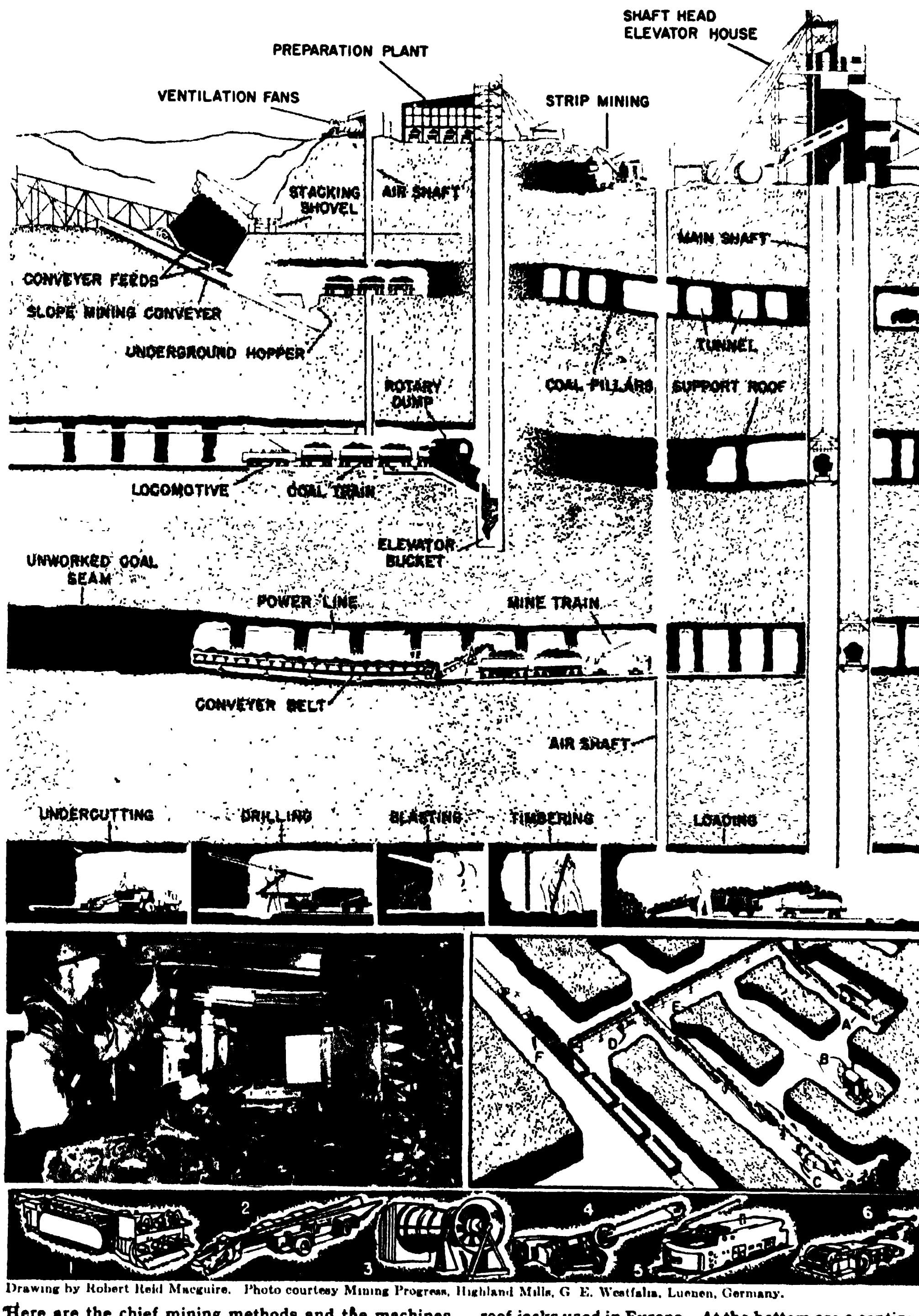
along the Pacific coast. California has almost none—she makes up for its lack by her rich supplies of oil.

Even though men are burning up their coal very, very fast, many careful scientists assure us we need not worry. Their experiments in recent years have taught us how to double the power of every ton that is mined. But even if exploration proves that we have enough to last only some 3,000 years, our civilization will not run down. We shall have the energy stored up in atoms of uranium.

Trying to Capture Sun Rays

Although no one can say just what will happen, it is nevertheless almost certain that long before the last shovelful of coal is thrown into the last furnace still other means of getting heat and power will have been discovered. Hundreds of scientists are working to find out practical ways of storing up some of the heat that the sun is constantly lavishing upon us, or of harnessing some of the power that is spent in the ebb and flow of the tides. When all these sources of energy have been developed nations will no longer feel that they must go to war to grab the coal supply that other nations happen to own. People will no longer say that the nation with the greatest coal supply is the one with the greatest future. Of course there are plenty of people now who are wise enough to know that this is not true; but after the discovery is made there will be a great many more who will see that that nation is great which has the brains and the enterprise and the perseverance to find out new and better ways of getting heat and light and power to advance its comfort and well-being.

And when that great day comes we shall not have to have thousands of men working in dark caverns underground. That will be a great step in advance, for a miner's life is full of danger and discomfort. Some coal beds lie near the surface, but others are deep in the bowels of the earth, under oceans and inside mountains. For as the earth's crust was wrinkled and folded, parts of it that



Drawing by Robert Reid Macguire. Photo courtesy Mining Progress, Highland Mills, G. E. Westfalia, Luenen, Germany.

Here are the chief mining methods and the machines they use. Coal not deeply buried is mined by the slope and bucket methods. Coal at the surface is stripped away by shovel. The deepest seams are worked from a central shaft. The photo shows a planing machine and roof jacks used in Europe. At the bottom are a continuous miner, duckbill loader, air blower, shortwall cutter, locomotive, and drill. In the drawing above them are the continuous miner (A), undercutter (B), duckbill (C), conveyer (D), coal pillars (E), and coal cars (F).

were deep down were often raised, and other parts were sunk and covered over. In Belgium there are mines four thousand feet deep.

Down in a Coal Mine

A mine is an amazing place, a human ant hill full of long corridors where hundreds of men come and go every day. One goes down into it through a great opening called a shaft, a hole that is dug straight down into the earth. It is some twelve feet wide on an average, and is sunk to the very bottom of the lowest "seam," or layer, of coal. It is divided lengthwise into four compartments. Through one of these water is pumped out of the mine—for of course in digging so far into the earth one is certain to meet underground streams. Another compartment is used for pumping air into the mine. And the other two compartments contain elevators for carrying the men up and down and for bringing up the coal.

These elevators, or hoists, are so arranged that when one car, or "cage," goes down the other one comes up. A powerful engine operates them, and other engines drive the dynamos that generate electricity to light the mine, or furnish power to certain mining machinery, or keep the ventilators and pumps working.

From the shaft, corridors extend out into the coal in every direction. They are not often level, for the seams of coal are not usually straight, and the corridors must follow the seams. Whenever it is possible, the miners try to build the corridors to slope upward from the bottom of the shaft, for then the little cars that carry the coal to the shaft will run downhill of their own weight when they are loaded, and only the empty cars will have to be hauled uphill.

How We Dig Coal

Down all the corridors run steel tracks for the little cars, or small trucks, that bring the coal to the shaft, ready to be loaded for hoisting to the surface. In every direction these little tracks make their way into the heart of the earth, sometimes for several miles.

A mine that has been worked for any length of time is full of chambers at different levels, all of them separated by walls and pillars of rock and coal that have been left to hold up the roof, and by timber and steel that are put in to strengthen the support.

Coal, especially anthracite, is nearly as solid as rock and must be loosened by drilling and blasting, or by boring with electrically driven machines. These are set to work in the ceilings of the underground chambers, and when the rock has been well loosened the coal falls of its own weight.

Then the coal is loaded on little trains and taken to the shaft. These trains are drawn by powerful locomotives which can handle many tons at a time.

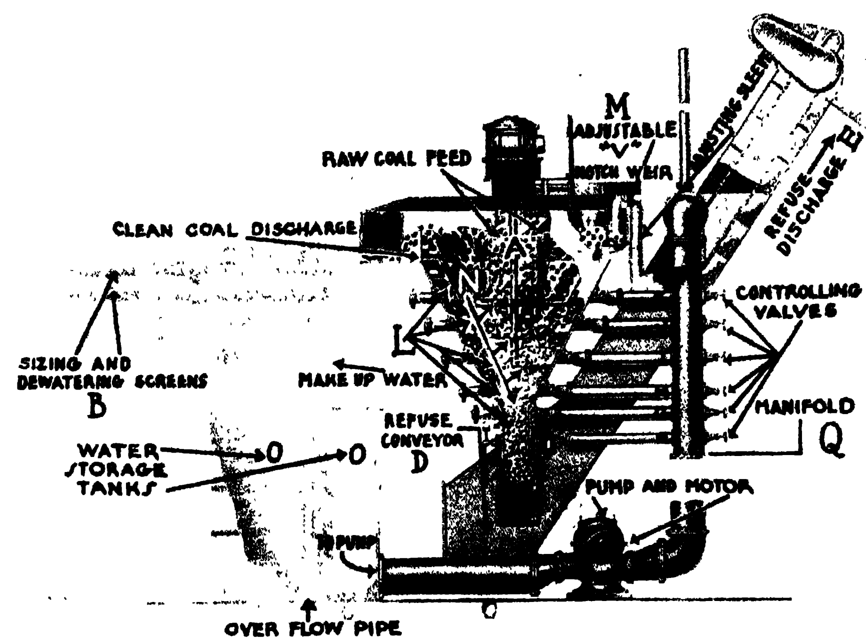
A century ago women and children were used to drag out the coal. They were replaced by mules and horses that were often born in the mines, never to see the sun. In the few American mines where animals are still used, it is the custom to bring them into the open from time to time

Coal Mining Is Dangerous Work

Coal mining has always been haunted by risks of many kinds, but persistent study of the means of avoiding accidents has done much to reduce the danger to the men who work deep in the bowels of the earth. The worst threat is still the cave-in of walls and ceilings which have not been properly shored up. A new technique for preventing cave-ins uses 8-foot anchor bolts, called "skyhooks," to fasten weak layers to firm rock. Another cause of disaster, explosions of coal dust, has led to spraying powdered limestone over the tunnel surfaces. By mixing with the coal dust the limestone checks the spread of explosions.

A Lamp to Stop Explosions

One of the greatest dangers has been entirely done away with. The little candles that miners used to wear on their hats set fire to the natural gas, called "fire damp," which is always present in a coal mine. It seeps into the air from pockets in the coal, where it has been imprisoned for millions of years ever since, under pressure from above, it was made from the giant plants that lay rotting in the swamp. Sir Humphry Davy



Photograph by Blue Coal Corporation

Small pieces of coal are sorted in machines like the above. A rising current of water agitates the mass of coal and refuse in the cone-shaped container (N) in the center of the picture, and bits of slate, heavier than the coal, fall to the bottom at D into the refuse conveyor to be carried out by the conveyor and discharged at E, on the right. The cleaned coal goes its own way to the left and falls into screens, at B, which "size" it that is, sort it into uniform sizes. The coal enters the machine at A, and the water, stored in tanks at O, is pumped by the pump shown at the bottom of the picture. Valves--as at L along the sides of the container N control the flow of the water into the container.

invented a safety lamp that greatly reduced the number of accidents in many European mines. Today the miner carries on his cap an electric lamp powered by a battery attached to his belt. This is perfectly safe in all circumstances.

Safety Is a Constant Concern

There are inventions, too, to detect gas in the tunnels. Radio and telephone keep the men in the farthest galleries in touch with the central shaft. Alert inspectors seek out any signs of flood, explosion, or cave-in. Instructions in safe mining practices are given the miners, for carelessness means certain trouble. To deal with accidents our up-to-date mines maintain mobile safety stations to provide rapid aid. But in spite of caution, disasters occur. Mining in general is still a hazardous occupation

As it comes up the shaft much of the coal is in pieces too large to be used in a furnace. The cars in which it is loaded must be hauled to the top of a large building called the breaker house. There the coal is dumped into great hoppers and slides down chutes to rollers that crush it into smaller pieces. From the rollers the crushed coal passes over screens of various sizes and through machines that sort out the lumps of the same size and remove any rock and slate that may be in it. Each size falls into its proper hopper and is carried to its bin, where it is loaded on freight cars for shipment.

Bricks That Burn

The different grades of coal, in the order of their size, are lump, steamboat, broken,

Photo courtesy Bituminous Coal Institute

A pair of locomotives like these, built especially for use in a modern coal mine, can do quickly the work of scores of the toiling animals of earlier days. Electric power for the engines is carried in overhead wires.

egg, large stove, small stove, chestnut, pea, buckwheat, and dust. Buckwheat is the smallest size that can be readily burned in a stove or boiler furnace, so the mines used to throw away as waste thousands of tons of coal dust every year. But not long ago a way was found to make valuable fuel out of this waste. It is put into tanks of running water to separate the coal particles, which are light enough to float, from the sand and stones that are mixed with them. The floating dust is then dried, mixed with pitch, and pressed into "briquettes" (brĭ-kĕt')—little smooth lumps of coal that make very good fuel. Most kinds of soft coal cannot be run through the breakers. The chunks are washed and sorted as to size, just as anthracite is.

The price of coal depends largely on the cost of transportation, for the cost of mining is relatively low. If coal has to be carried long distances by rail, the cost is very great, but if it can be shipped by water the expense is much lower and the coal will be cheaper.

Some Things We Get from Coal

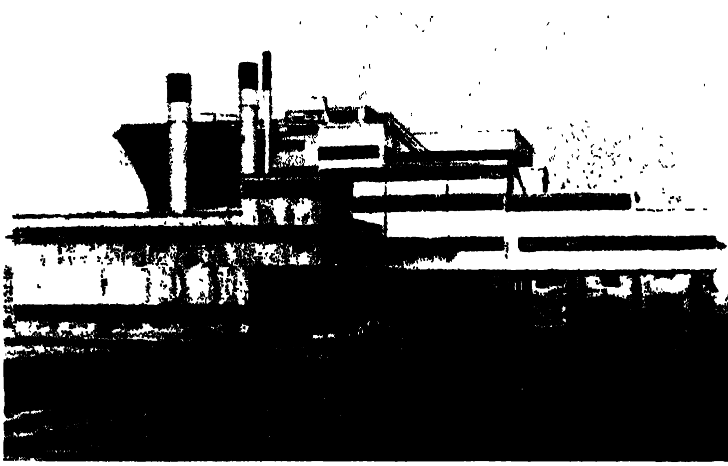
Now strange as it may seem, coal will give us a great many things besides heat, though of course that is what we use most of it for—to warm our buildings, to get up steam to run our factories and trains and ships, and to heat the crucibles in which we melt our ores.

But it will give us light as well, for it is turned into electricity in our great lighting plants, and in the gas works it is turned to gas, which yields both heat and light. When gas is made, soft coal is inclosed in an air-tight oven and great heat is applied. The gas and tar that the coal gives up are then run into condensers. The gas is cooled and purified and then forced into a great gasometer (găs-ŏm'ē-tẽr), or gas holder. A ton of coal will give off 10,000 cubic feet of gas, 21 pounds of a chemical known as ammonium sulphate (sŭl'fāt), 8 gallons of tar, 1,500 pounds of coke, and small amounts of benzol, toluol, xylol, and naphthalene.

Jewelry from Cannel Coal

The best of all coal for making gas is the kind we know as cannel coal—or "candle" coal, as it is called in some parts of England, because it burns with such a bright flame. It is not of much use as fuel, though it makes a merry fire. Because it will take a high polish we make one variety of it into jewelry and other ornaments. Then it is known as jet. Long before the dawn of history men were making ornaments out of the jet that is found in Yorkshire, in England; and in the old, old monastery at Whitby, on the Yorkshire coast, it was fashioned into beautiful rosaries. The same section still gives it to us, and so does Spain as well.

Coke is a valuable fuel made from coal. It is used for smelting ore because it will give such an intense, clear heat. It is very clean to handle; and has a hard, silvery-gray luster if it has been prepared especially for smelting purposes. It is porous and brittle, and will ring when it is struck. But if it is what is



When coal is brought out of the mine it goes to a preparation plant like this one. Here it is freed of any refuse, washed and dried, and crushed to correct size. Only then is it ready for marketing.

Photo courtesy United States Bureau of Mines

left when gas has been made, it is dull black and not so hard, though it is still excellent fuel.

There are two ways to make coke. The older method used a "beehive" oven which allowed all the gases and by-products to escape. More often it is made by the Koppers process in a "by-products" oven, which saves the very valuable gases and by-products. We have already seen the uses the gas is put to. The coal tar serves a great many more purposes, for out of the various substances it contains, so many new and useful things can be made that one is almost tempted to think the dream of the old alchemist has been realized. The base substances are not exactly turned into gold, but they are made into things so valuable that the greediest man ought to be satisfied.

Dyes and Perfumes from Tar

Coal tar, when it is distilled in the giant stills that hold many tons, will yield ten substances known as "crudes," and these can in turn be treated chemically and made to yield many others, which, combined and re-combined, serve a multitude of purposes. From the dark, sticky stuff we know as tar come gorgeous dyes, tons of perfume, the most powerful of all explosives, flavors for ice cream and soft drinks, moth balls, carbolic acid and other drugs and medicines, "anti-knock" for gasoline, many kinds of plastic like bakelite, creosote and a whole list of disinfectants, motor fuel, nylon, synthetic rubber—and many other things. No wonder the chemist loves the smelly stuff!

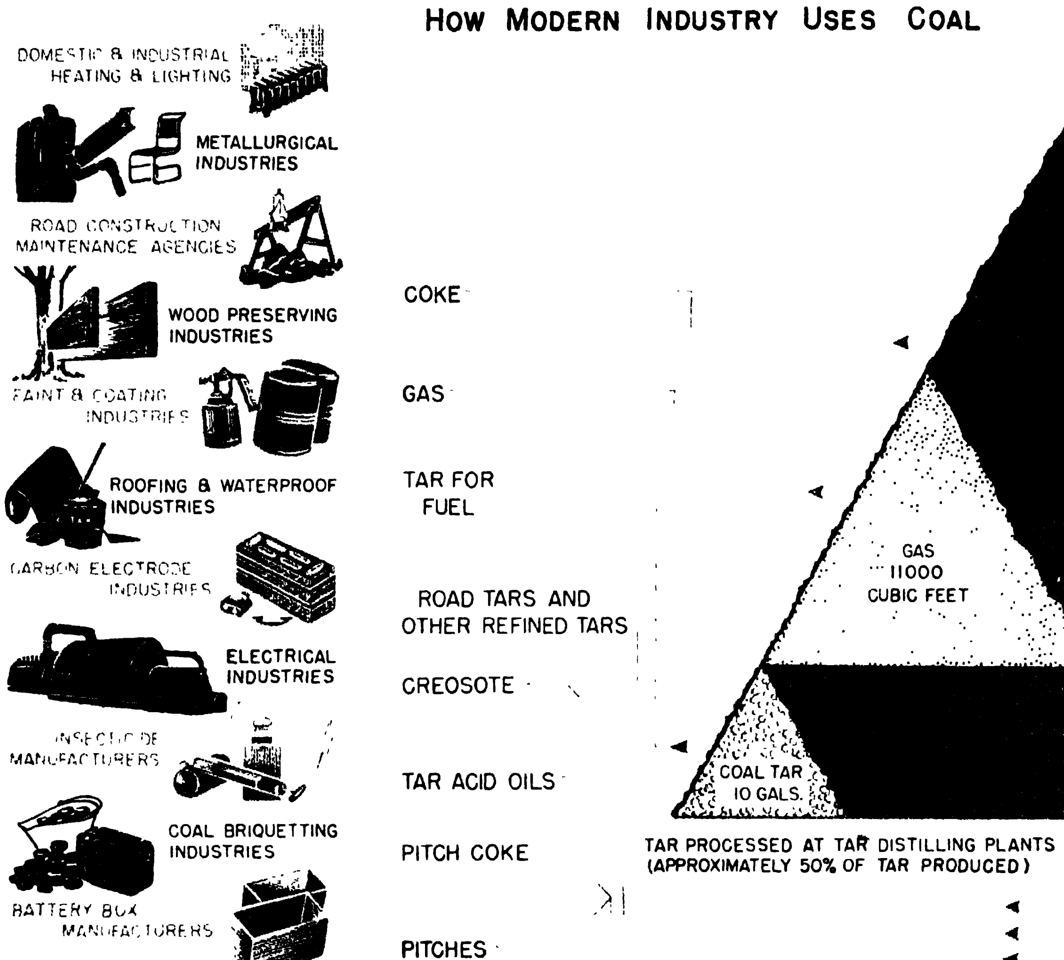
The Wonders in a Lump of Coal

The tar itself serves many uses. It protects wood and iron against the weather, is used for tarring ropes, and when certain properties have been removed is widely used for tarring roads or binding various road surfaces. After still other substances have been taken out, the pitch that is left goes into various kinds of paints and varnishes.

When the tar is heated to somewhere between 212° and 230° F. it gives off crude naphtha. This first distilled product—or "fraction," as it is called—yields, under treatment, a valuable motor fuel; what we know as aniline (ăn'ĭ-lĭn) and other dyes; a substance that goes into the terrible explosive T.N.T.; a material of great use as a paint and varnish remover and as a cleaning fluid; and a substance known as saccharine (săk'á-rĭn), which, in its pure state, is 550 times as sweet as sugar.

As the heat is raised up to 390° F., we get the second "fraction," a light oil from which may be made solvent naphtha, of great use for cleaning fluids and for removing paint and varnish; heavy naphtha, used as a fuel and yielding certain resinous substances that go into the making of varnish; a medicine for asthma; certain dyestuffs; a number of antiseptics; and a substance known as artificial musk, which goes in large quantities to the making of perfumes.

The third fraction, which comes away as the temperature is raised to 480° F., contains

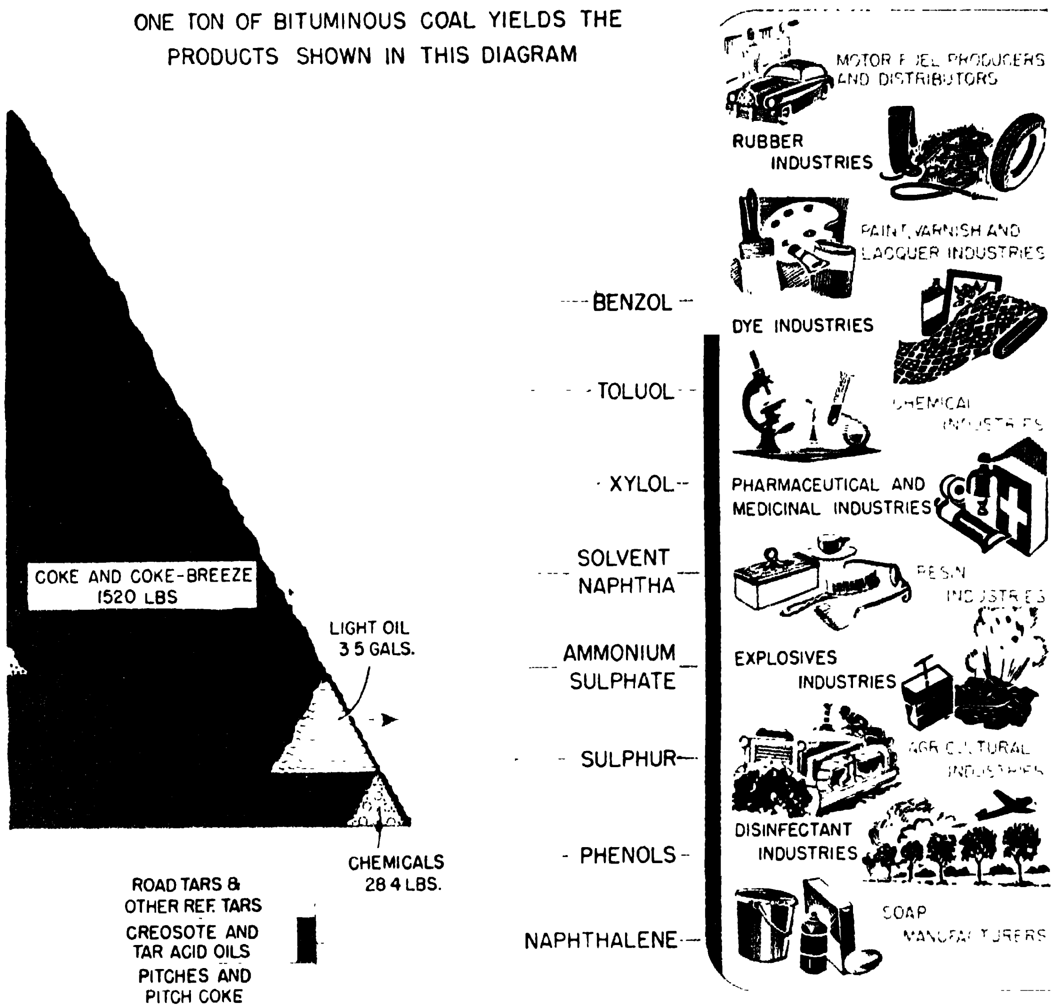


Drawing by Robert Reid Macguire

This diagram shows a few of the marvelous substances which science has made from coal. As you see, in making coke more than three-fourths of each ton of coal becomes coke or "coke-breeze" the refuse left in coke making. Although coke was known in China 2,000 years ago, it was not until our own time that serious

crude carbolic oil or light creosote (krē′ō-sōt). This is a very important fraction. It yields naphthalene, which we know in moth balls and which goes to the making of dyes and explosives, and it yields carbolic acid, or phenol (fē′nōl), which goes into the explosive known as lyddite (lĭd′īt). From phenol we can make compounds which are useful as cathartics, as medicines for treating skin diseases and burns, and as tear gas in time of war. It goes into many surgical antiseptics and sheep dips, into dyes and soaps and tooth powders, and into photographic developers. Salicylic (săl′ĭ-sĭl′ĭk) acid, another substance made from this fraction, is much used as a medicine, and is a powerful food preservative. It goes, besides, into various brown and yellow dyes.

From this fraction, too, come various compounds that go into solid substances that we use almost every day of our lives. One of the best-known of these is bakelite, which was invented by Professor L. H. Baekeland of Columbia University. It often looks a good deal like clouded amber, though it may be dyed different colors; and since it resists heat, water, acids, and is a non-conductor of electricity, its uses are too numerous to mention. Of course it is highly valuable for electrical installations, and serves, too, for



thought was given to that part of the treated coal which was going to waste. The closed coking oven saved the smoke, and chemistry transformed it into valuable products. From the smoke and the by-products of coking which are listed around the center pile, more than 200,000 useful things have so far been made.

making all sorts of useful and pretty articles – beads, pipes, jewelry.

The fourth fraction, which comes away when we raise the heat to 535° F., yields heavy creosote. It is very good to burn in Diesel engines, and can be made to yield us scarlet dyes and a substance that goes into perfumery. When posts and piles and railway ties, or any other exposed woods, are treated with it their life is lengthened four or five times. It, too, goes into disinfectant soaps and powders and sheep dips.

The fifth fraction of coal tar is anthracene (ăn′thrȧ-sēn) oil. It comes away as the temperature is raised to 660° F. From it we can get various substances used in tanning, and red, orange, and violet dyes.

After all these fractions have been taken from the original coal tar, only pitch is left.

Chemists have now found some 200,000 new and useful things to be made out of the amazing substances we have been talking of, and one of the greatest uses of the compounds that they have already discovered is in the carrying on of all sorts of chemical processes. What a fascinating study the chemistry of coal must be! Whenever we take an aspirin tablet, we are swallowing something made out of a bit of coal. And from the same lump we get choice perfume!

Reading Unit No. 9

THE ROMANCE OF OIL

Note: For basic information not found on this page, consult the general Index, Vol. 15.

For statistical and current facts, consult the Richards Year Book Index.

Interesting Facts Explained

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The thickness of oil, 9–450
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How does a geologist locate oil fields?
How does machinery depend upon oil wells?
Why did oil become more valuable after the invention of the automobile?
What is going to happen when the world's supply of oil gives out?

Picture Hunt

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Summary Statement

The oil which has lain in the earth for many ages, now gives light and power and heat to man.

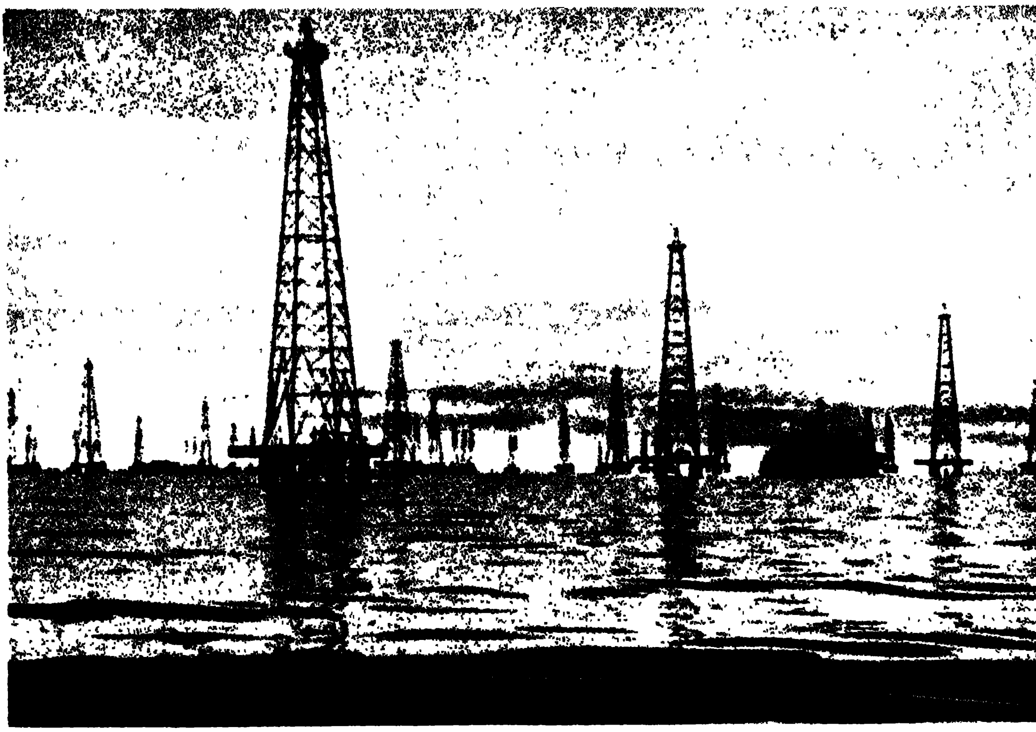


Photo by Vachon courtesy Standard Oil Co (N J.)

With the aid of delicate instruments like the seismograph geologists have located rich stores of oil hidden under water. These derricks standing in Venezuela's Lake Maracaibo mark an important new field.

The ROMANCE *of* OIL

How the Little Creatures in the Ocean Made Our Petroleum Millions of Years Ago, and How We Found It Only Yesterday

THERE have been certain places on the earth that have been on fire for many a century. Out of a hole in the rock a great flame has burst forth and gone on flaring year after year. And long ago the simple men who saw the sight would fall down on their knees in awe and wonder. For they had no notion of what started the flame, and they could not see why fire should burst out of rock. They simply took it as some sort of sign from heaven.

But now we know that in many places there is oil near the surface of the earth or even seeping through it. And sometimes the natural gas that comes with oil finds a way to pour out into the air through some cave or crevice in the rock. If it manages to catch fire, it may keep on burning for many a year. So there is no miracle about the fire, except as everything around us is like a miracle—and all the more as we learn more about it.

For instance, there is a long romance about the way the oil first got into the earth. We are not quite sure about it all, but we believe the oil came from billions and billions of living things, plants and animals far too small for us to see, that used to live in the ocean or float down with the rivers ages ago.

When the tiny creatures died and sank to the bottom, their remains were mingled together, layer upon layer, and covered over with sand and mud. Under the enormous

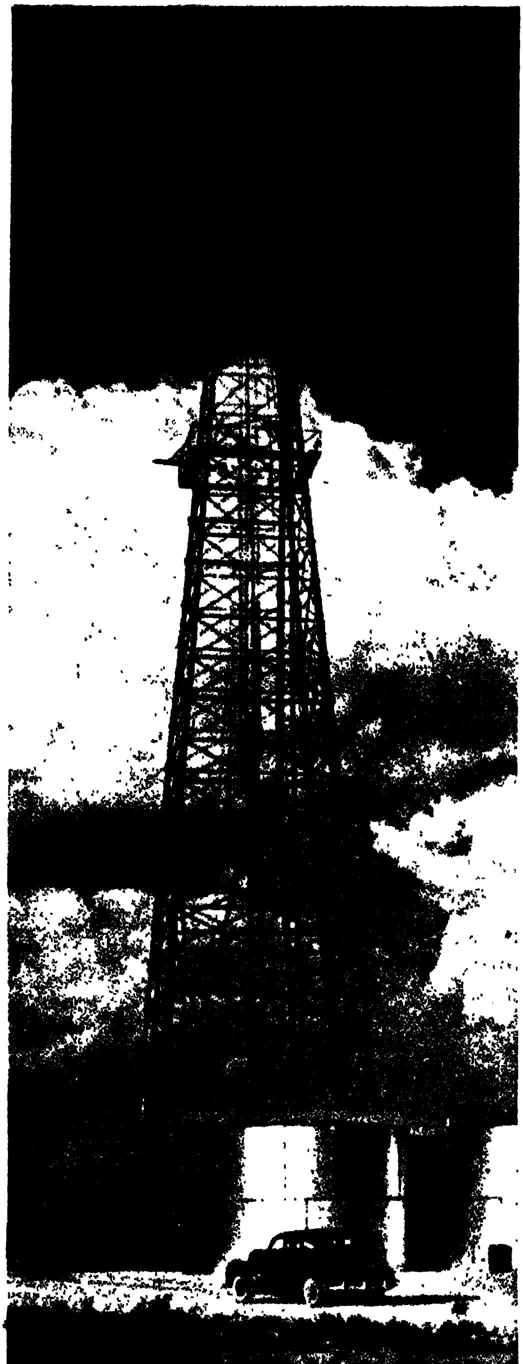


Photo courtesy Shell Oil Company

This 204-foot derrick is one of the tallest in the world. Drills have to be changed frequently wherever hard rock formations wear out the bits quickly. Since this derrick will take longer drill stems than other derricks take, it makes possible quicker changing of the drills. At the base of the derrick are the tanks which store water used in drilling, and the "doghouse," or office.

pressure of the earth and water above them, they were finally turned into rock. During the long ages following, the rock was forced up out of the ocean and became part of a continent; and during those long ages, under heat and pressure, the countless little remains of plants and animals might sometimes yield the particular compound of hydrogen (hī'drō-jĕn) and carbon that makes petroleum—which is the correct name of the oil we are talking about. In the original Latin it means "rock oil." This useful substance lies in underground deposits distributed through sand and limestone.

The oil is a sticky, smelly stuff black or yellowish—that kills the grass or other green things near it. When it collects in a pool on the surface it will sooner or later dry up and leave a bed of pitch. When it can flow away through the earth it may be lost forever It is the oil that was collected in "traps" in the earth—in the irregular layers of porous rocks sandwiched between two layers of non-porous rock—that man has been able to find and use.

Man Was Slow to Find Oil

He was a long time finding it, too. The Chinese are thought to have drilled for gas and oil as long ago as fifteen hundred years. But in the Western world no use was made of petroleum until about a hundred years ago. In fact, we did not realize how useful it could be. In 1847 a Scottish chemist named James Young was asked to see what he could make of a heavy black liquid that was flowing like a spring out of a coal mine. When he set to work on it he found that by boiling or "refining" the liquid he could produce three things: a light oil to burn in lamps, a heavy oil for machinery, and paraffin wax.

At this time people thought of oil mostly as being just a nuisance—or worse. When they drilled wells to get brine for making salt they were more than annoyed when they sometimes got brine mixed with sticky oil. The brine was ruined. But as soon as they knew that oil itself had a value, and learned how to use it, they began to dig for oil.

The first real oil well was drilled in 1859. It was at Titusville in Pennsylvania, and was the work of Edwin L. Drake, a railway conductor who came to be called Colonel

Drake. He was the first man to prove that we could get oil from the oil deposits. He had to drill only sixty-nine feet deep before the oil began to pour out at the rate of twenty barrels a day. But like many another discoverer he died poor because he was not a very good business man. Some of the people he had enriched by his discovery took care of him in his old age, and later put up a statue of him.

One of Our Biggest Businesses

Well might we have a statue of Mr. Drake! For his small well was the start of the immense oil industry we know today--in the United States an industry second only to agriculture in the dollar value of its products and one that in one way or another employs a million and a quarter people. In 1859 just two thousand barrels of oil were taken out of the ground in the United States. Now we must multiply that number by exactly one million to get the annual "take." The richest fields are in California and Texas. The United States uses more oil than any other country.

Many a princely fortune has been made from oil. And men have often lost everything they had trying to strike it rich. Frequently along with their own money went the money they had persuaded other people to invest in the venture. For oil has been an expensive and risky business. In the early days of the industry "wild catting" was common—that is, drilling wells on the gamble that oil might be found. When drilling really yielded oil in a given area, thousands of men were likely to come rushing in to try their luck. It was a common sight to see a rich field studded with hundreds of derricks—those open towers of steel that rise above the wells. Often they stood hardly more than fifty feet apart.

Finding Oil Is a Science

But the years have brought knowledge and many changes have taken place in our methods of finding oil and taking it from the earth. Today drilling is the last step in man's quest for oil. And though no one can prove that he has oil until he brings it up, drilling does not usually take place at all unless there are pretty positive indications that it will

Photo courtesy Shell Oil Co.

The geologist in the top picture is reading a device called a magnetometer, which records the varying magnetic pulls of underground rock structures that are possible traps for oil. Below, you may see what an oil driller sees when he looks up through the derrick. Three lengths of drill stem are hanging beside the hose which supplies mud to the drilling bit.

Photo courtesy Standard Oil Company of Louisiana

These men are sealing the sections of a pipe which will carry oil cheaply and steadily under the waters of the Mississippi River to the industrial centers of the East coast. When the buoys which you see in the river are removed, the pipe will rest on the river bottom.

Photo courtesy Standard Oil Company of New Jersey

Here is an oil rig, complete with Diesel pump, storage tanks, and living quarters. It stands seven and a half miles offshore in the Gulf of Mexico. When its tanks are pumped full, barges from the mainland collect the oil.

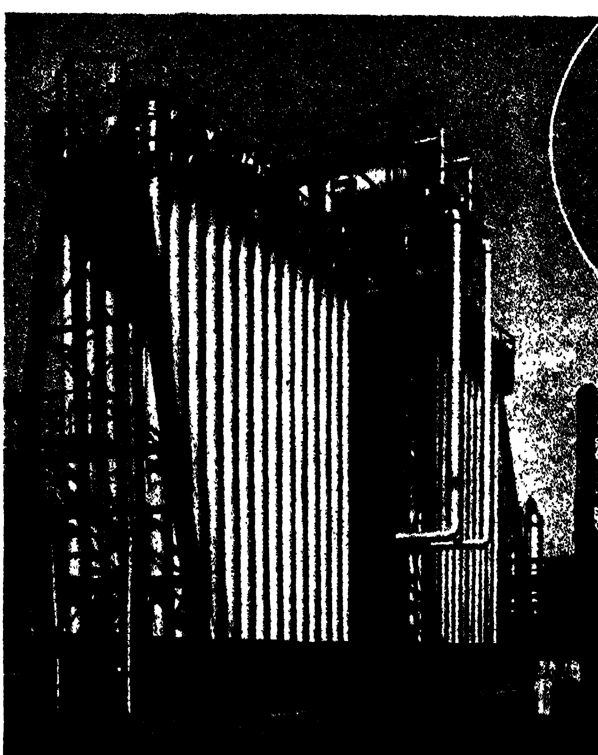
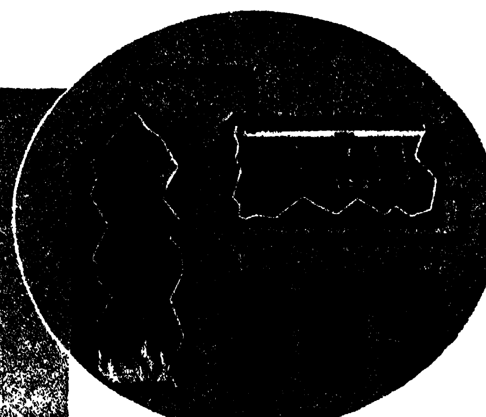
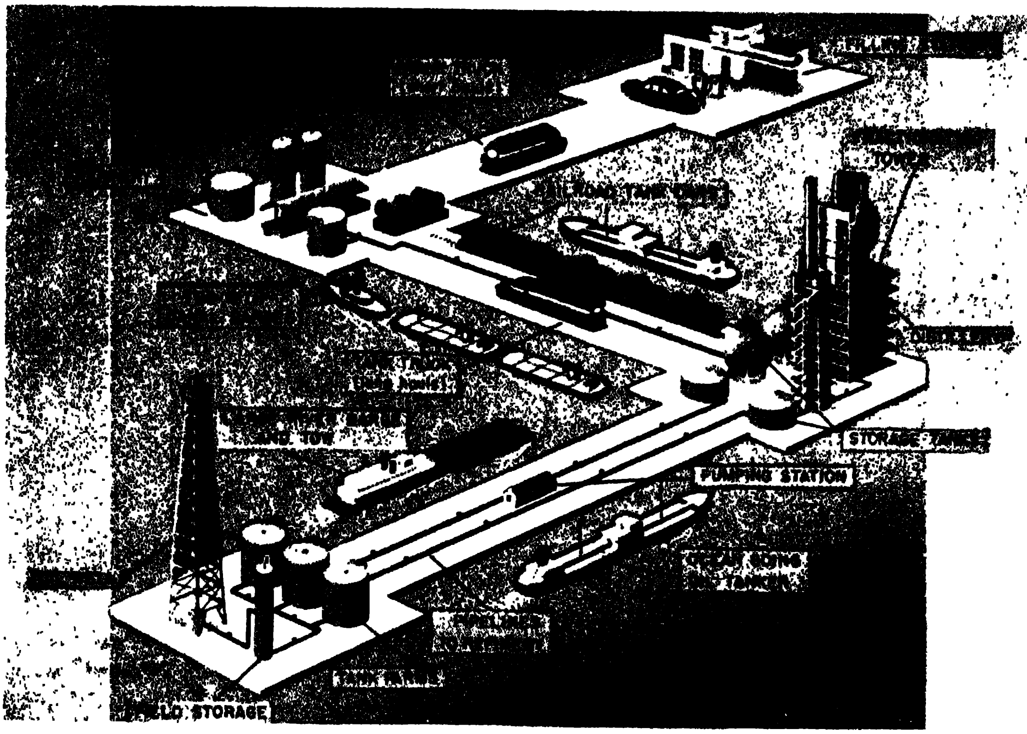


Photo courtesy Shell Oil Company



The drawing above shows the principle on which an oil still works. Oil in the upright tank is heated until it begins to give off vapor. This vapor is carried by the pipe at the top of the tank to the coils in the condenser, at the right. There the vapor is chilled and turns to a liquid, which runs into one of the tanks below. As the crude oil is heated to higher and higher temperatures it yields up different parts of its substance as vapors, called fractions.

The huge structure at the left is called a petroleum pipe organ. Its technical name is "polymerization plant," which means that it is making a new substance out of an old one without adding any elements or changing the proportions of those already present. The result, called a polymer, will reduce "knock" in automobile gasoline.



Courtesy Standard Oil Company of New Jersey

As this diagram suggests, the job of moving the 63-billion-gallon flood of oil that the United States uses in a year from the well to the service station needs many vehicles—140,000 miles of pipeline, 650 ocean-going tankers, 2,000 barges, 142,000 railroad tank cars, and thousands of tank trucks.

yield oil. No wonder when one well may now go down as far as four miles and cost over half a million dollars!

Today's "oil hunters" are geologists, and they are constantly at work trying to find new oil fields. The oil hunter has many ways of "feeling" into the earth to find if the conditions indicate oil traps beneath. He has a knowledge of the kind of rock formations that are likely to trap oil. Instruments that measure gravity and magnetism help him to know the kinds of rocks that lie beneath the surface. Or he may get a clue by passing waves of electricity through the rocks. Some rocks resist electricity more than others, and he knows how to "read" the story the electric waves have to tell. The commonest method, however, is to produce a small earthquake by setting off a stick of dynamite and then measuring and timing the waves on a seismograph (sīs'mō-grăf) a short distance from the quake. After a number of tests have indicated that there may be oil in an area, an exploratory well is drilled to make sure one is worth while.

The World's Oil Supply

Enough scientific testing of this kind has been done for us to know that there are at least about 60 billion barrels of oil in the world. Approximately one-third of this is in the United States. The Middle East—Saudi Arabia, Iraq, and Iran—has about 26 billion barrels. Venezuela, Russia, and the East Indies also have large known supplies. Of course the world's real store of oil has only been guessed at as yet, but the amount has been estimated to be as much as 600 billion barrels. Some experts think this estimate is too high. They point to the way oil has been wasted by careless drilling methods and by fires, and to the speed with which our modern way of life uses up oil. They warn us that we must be more conservative—more intelligent in our use of oil—if we are not to run out in a few years. The machines of modern warfare fairly drink oil, and they would be useless without it. There has been

much concern over what World War II did to the world's oil supply—to say nothing of what a third war might do.

It is our ever-growing use of oil and the need to use it without waste that have helped bring about the changes in drilling and sent geologists on the hunt for more of it. It is no longer considered good practice to crowd hundreds of wells in a small area. Drillers are required by law to be more careful to prevent the kind of fires that have destroyed untold quantities of oil. Gushers—geysers of oil that shoot into the air from a very strong new well and go to waste before they can be tamed—are no longer common because drilling is better planned and regulated. By today's methods of taking the oil out of the earth slowly, as much as four-fifths of a deposit can be brought up. A few years ago men expected to take off what they could get quickly and easily, leave as much as three-fourths of a well's wealth to go to waste, and hurry on to new fields.

Drilling an Oil Well

Most of our oil is tapped today by what is known as a rotary drill. A brace which lies on the floor of the huge derrick turns a giant bit at the end of a hollow pipe. As the bit grinds through the layers of rock, a "mud" made of chemicals, clay, and water is forced down the hole at the same time and the hole is lined with pieces of steel pipe that fit together like the parts of a telescope. The mud, bringing piles of chewed rock with it, is forced to the surface as the drill and pipe go down. This mixture—or "core," as it is called—is then tested continuously for oil. When oil is found, the drill is carefully removed while the remaining mud keeps the oil from gushing, and the opening is sealed. As soon as the proper pipelines and control valves are constructed on the ground, the well will be ready to flow. Of course there may not be enough pressure to bring the oil to the surface and a pump, not unlike those used to pump water from a well, will be put in to hurry the flow along.

The crude oil which comes from the well and flows off through the attached pipelines to storage tanks is not yet ready for use. It has to go to a refinery. And it usually has to travel some distance to get there. In some instances a pipeline is built directly to the refinery to carry it. Often pipelines are laid to take it to railroad tank cars or to seaports where it is pumped into oil boats, or tankers, to be transported. No matter how it is carried at this stage, much of our oil travels underground for hundreds of miles not only to reach the refinery but again to go to consumers after it has been refined.

At the "Cracking" Plant

In the old days refining oil meant "boiling" it, and boiling or distilling is still the first step. But oil does not boil the way water does. Water always boils at a single temperature, while oil can be boiled at several different temperatures and with different results.

When oil reaches a certain temperature it gives off gasoline in the form of vapor. This is carried off in pipes that run through cold water. In this way the vapor is turned back into liquid and emptied into a tank. When the gasoline is all boiled away, the oil is heated to a higher point where it gives off kerosene, to be stored in another tank. Then the heat is raised again and we get the fuel oil that is used in furnaces. And so we go on until we have nothing left but a heavy kind of oil or asphalt.

Modern oil refineries—or "cracking" plants, as they are called—do not stop with the rather simple process described above. Besides heat they use pressure and sometimes a chemical called a catalyst (kăt'ă-lĭst) to "break" up the oil and make the heavier oil products yield more light ones. This makes a barrel of crude oil much more valuable. But the oil scientists have gone even farther and learned how to tear the molecules in oil apart and put them together again in new patterns to make completely new products. Polymerization (pŏl'ĭ-mẽr-ĭ-zā'shŭn) is the name given one of the processes by which scientists "make over" petroleum and change it into "custom built" materials to suit modern man's needs.

Men have learned to make hundreds of things out of petroleum, but a few are much better known than all the rest. Americans are likely to think of gasoline first, as would

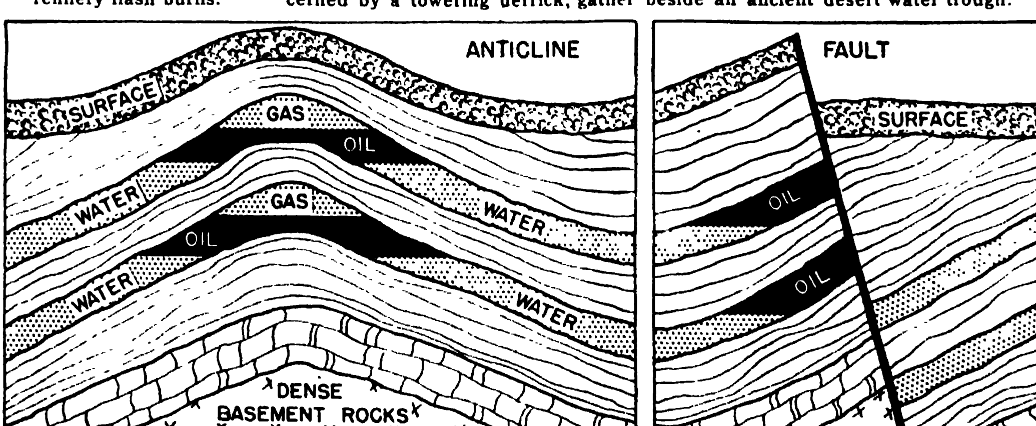
A masked pumper need not fear deadly sulphur fumes.

Goggles and respirator protect air-hoseman from grit.

Asbestos guards against refinery flash burns.

Photos courtesy Standard Oil Company of New Jersey

Here, as they always have, Saudi Arabian tribesmen and their camels, unconcerned by a towering derrick, gather beside an ancient desert water trough.



Drawing by Robert Reid Macguire

Petroleum, which includes both crude oil and natural gas, is found only in porous rocks. Here are two of the commonest kinds of petroleum traps. An anticline is a dome caused by upfolding rock. Oil and gas are trapped at the top of the dome, since neither the oil nor the salt water on which it floats can seep through the solid rock below. A fault is the result of a slip in the earth's rock crust. When a fault leaves solid rock next to porous rock, a petroleum trap is formed. Oil can gather on either side of a fault.

Photo courtesy Shell Oil Co.

These spheroid tanks with their flat surface resting on earth are storing natural gas under pressure. Behind them are tanks called "spheres," the strongest form of tank, in which butane and isobutane gas are stored.

the people of any nation with 40-odd million automobiles on its highways. Kerosene is still needed for millions of lamps and stoves. Fuel oil is used more and more every year for heating homes. Diesel engines in ocean liners and trains require fuel oil, too. Our machinery upon which we depend for almost everything that makes our lives comfortable would stop moving were it not for the lubricating oil that comes from petroleum. Tar and oil are common coatings for highways. Much of the wax in our candles comes from oil. We should be without naphtha, benzene, and vaseline if we had no oil, while cosmetics shelves would be almost bare without it. Among the newer products which we already take for granted are the high octane gas for airplanes, synthetic rubber, and plastics to make into countless other articles. Meanwhile the list—already a big one—grows longer all the time.

Where Do We Get Natural Gas?

Wherever oil is found in the earth we find natural gas with it. When an oil well begins to give up its oil the natural gas comes up, too. We used to let the gas escape, but now it is pumped off to towns and cities where it is used for fuel. Natural gas is found apart from oil as well as with it. Most of what is used in the United States comes from wells that have been drilled for gas alone—though they are much like oil wells. The states of Texas, California, Oklahoma, and Louisiana have great gas-producing areas. Thousands of miles of pipeline carry this gas to distant cities and on into homes and buildings. It is considered by some to be the best fuel in the world, but it lacks the many uses of the oil with which Nature so often "houses" it. We can be sure science will one day find new value in natural gas.